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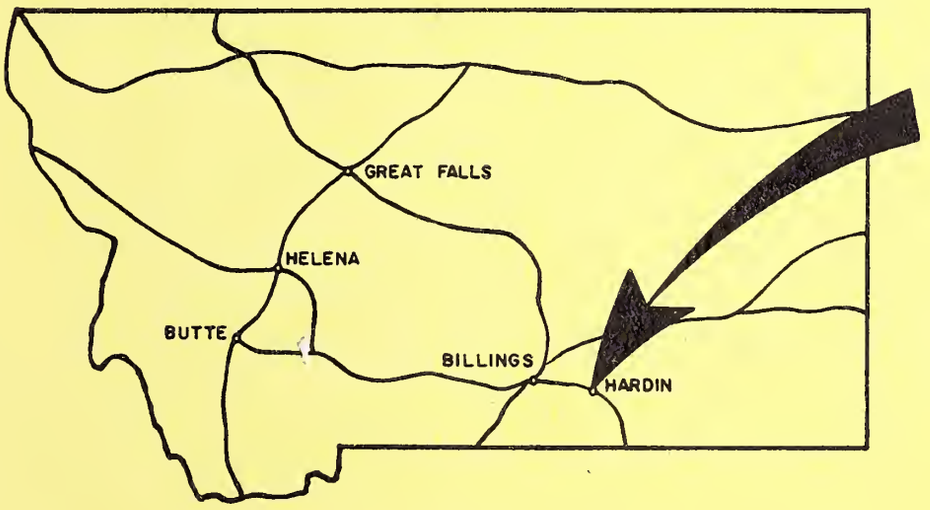
STATE DOCUMENTS

RECONNAISSANCE REPORT INTERSTATE ROUTE 90



ONE MILE EAST OF TOLUCA TO TWO MILES EAST OF HARDIN

1963

370

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RECONNAISSANCE REPORT

INTERSTATE ROUTE 90

ONE MILE EAST OF TOLUCA

to

TWO MILES EAST OF HARDIN

Prepared for:

HIGHWAY COMMISSION

STATE OF MONTANA

August 1963

THE KEN R. WHITE COMPANY

Helena, Montana - Denver, Colorado

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ENGINEERING
ARCHITECTURE
PLANNING
RESEARCH

THE KEN R. WHITE COMPANY
1567 MARION STREET • DENVER 18, COLO. • 255-0337

19 August, 1963

Highway Commission
State of Montana
Helena, Montana

Gentlemen:

Presented herewith is the Reconnaissance Report covering the traffic analysis, the geologic and soils studies and alignment studies for the Toluca to Hardin Freeway, Interstate Project I 90-9(8)471.

The material embodied in this report represents results of considerable study on this portion of Interstate 90.

Frequent conferences with members of the Highway Commission and officials of the Bureau of Public Roads have greatly facilitated the logical development of this study.

It is our desire to express wholehearted appreciation for the cooperation received in securing comments, suggestions and factual data for use in the report.

This report has been prepared to serve both as a complete traffic report and a basis for final design of the project.

Very truly yours,

THE KEN R. WHITE COMPANY

Ralph L. Menasco

Ralph L. Menasco
Project Engineer
Montana Registration No. 2127E

Att.

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INTRODUCTION

Montana is traversed by Interstate 90 from the Montana state line north of Sheridan, Wyoming, across the state through Billings and on into Idaho. The Toluca to Hardin section of this route is located in the southeast corner of Montana.

The Toluca to Hardin study is comprised of three alternate routings - A, B and E. A and B Lines are the major routings as they traverse the study length in its entirety. E Line is an alternate of the A Line and was introduced in an effort to better serve the central business district of Hardin.

The routes all have the same beginning and ending points, the beginning point being one (1) mile east of Toluca. All references to Toluca in this report are to mean the existing overpass of U.S. 87 and the C. B. & Q. Railroad which is approximately 11 miles west of the City of Hardin. The ending point is the north limit of existing construction on Interstate 90, which is some three (3) miles southeast of the City of Hardin.

All of the study area lies in Big Horn County. Three basic types of farm land are traversed by the routings - irrigated, dry land and range. Every effort was made to traverse the area in a manner that would cause as little damage to these farm lands as possible

and still have sound economic route that would serve the area effectively.

The routings shown were developed after extensive field reconnaissance and study. Many lines were developed that are not included in this report. These were discarded when they failed to show merit under a more intensive field and economic study.

AUTHORITY

This report has been prepared in accordance with the agreement between the Montana Highway Commission and The Ken R. White Company, formerly Ken R. White Consulting Engineers Inc. This agreement gives the project number as I 90-9(8)471 and the name of the project as Toluca to Hardin.

PURPOSE

The purpose of this study was to determine the most feasible location for Interstate 90 from Toluca to Hardin and to prepare a report, which would include the economic analysis for presentation to the Montana Highway Commission.

BASIC DATA FOR DESIGN

1. Base Maps

   The original reproducible photogrammetric maps to a scale 1" = 400" horizontal and a contour interval of 10' were furnished by the Montana Highway Commission to this firm. The elevations shown on these maps are based on U.S.C.

and G.S. datum.

Field checks were conducted to check the maps for completeness and to add major utilities, including a 12" high pressure gas line, several small low pressure gas lines and many natural gas wells.

2. Traffic Data

The Montana Highway Commission furnished this firm with the traffic data required. This data included an origin and destination study of Hardin done in 1961 showing the desires of the motorist. It also included average daily traffic (A.D.T.) counts on roads in the area.

3. Standards

Design standards were submitted by this firm to the Montana Highway Commission for their approval. The approved design standards are listed below:

a. Typical sections as shown on Sheets 2 and 3 of the plans.

b. Design conditions - flat and rolling.

c. Traffic lane widths - 12 ft.

d. Design speed - 70 mph and 60 mph.

e. References:

(1) "A Policy on Design Standards", AASHO.

(2) "A Policy on Geometric Design of Rural Highways", AASHO.

(3) "Policy on Arterial Highways in Urban Areas", AASHO.

(4) "Highway Capacity Manual", U. S. Department of Commerce, Bureau of Public Roads.

(5) "Field and Office Standards", Montana Highway Commission.

(6) "Standard Drawings", Montana Highway Commission.

(7) "Standard Specification for Road and Bridge Construction", Montana Highway Commission.

(8) "Road User Benefit Analyses for Highway Improvements", AASHO, 1960.

(9) "Highway Traffic Estimation", The Eno Foundation for Highway Traffic Control, Saugatuck, Conn., 1956.

P A R T I

TRAFFIC

A. GENERAL INFORMATION

The following basic data was made available by the Montana State Highway Commission for the traffic studies:

1. An origin and destination survey conducted in 1961, by the Montana State Highway Commission. This covered the four main highways leading into Hardin: namely, U.S. 87 east and west of Hardin, State Route 47 north of Hardin, and FAS 313 south of Hardin.

2. 1958 and 1975 average daily traffic for various county roads and main highways around Hardin.

3. Information pertinent to the Interstate:

Directional Distribution . . .	55%
Truck Percentages:	
West of Hardin	15%
East of Hardin	12%
DHV Factor	13%

B. PROCEDURES

In addition to the zones used in the 1961 origin and destination survey, other zones and centroids were introduced around the City of Hardin as follows:

1. Considerable local traffic was evident in the area of the three county roads immediately west of Hardin. In order to assign this traffic, Zone "A" was established using a point midway of the three roads as the centroid.

2. Zones "B", "C" and "D" east of Hardin were established and their centroids so located that a common point on intersecting roads was available for all alternate studies.

3. Centroids in Zones 301, 302 and 303 were established with the aid of aerial photography, local inspection and probability of growth factors.

To determine percentages of traffic desire from the various zones outside the city, "T" intersection distribution was utilized from average daily traffic furnished by the Highway Commission.

By utilizing the 1961 origin and destination data and applying the values percentagewise to the given 1958 and 1975 average daily traffic, it was possible to determine traffic volumes for all interzone travel throughout the study area. Percentage of distribution for Zone "A" was derived from the origin and destination station west of Hardin, and for zones "B", "C" and "D" from the origin and destination station east of Hardin.

The 1958 and 1975 average daily traffic is shown on Figure I. Zone locations are shown on Figure II, the traffic desire diagram for the study is shown on Figure III. Schematics of the alternates and interchange locations are shown on Figure IV.

C. TRAFFIC ASSIGNMENT

Assignment of traffic was made by employing the method used by the California Division of Highways which is described in "Highway Traffic Estimation" by Robert Schmidt and M. Earl Campbell in "The Eno Foundation for Traffic Control," 1956. Logic was used in determining the routing of all trips between zones with three types of routings being considered:

1. Trips over existing streets and highways.
2. Trips avoiding use of the freeways referred to as "Freeway Haters".
3. Trips utilizing a maximum of freeway travel referred to as "Freeway Users".

Attempts to obtain travel speeds by the "floating car" method did not materialize, due to sparse traffic. The speeds used in the study were obtained from information gathered by the Montana Highway Commission from speed studies in the State and correlation of posted speeds on the city streets and roads with AASHO criteria.

1975 ZONE-TO-ZONE ADT

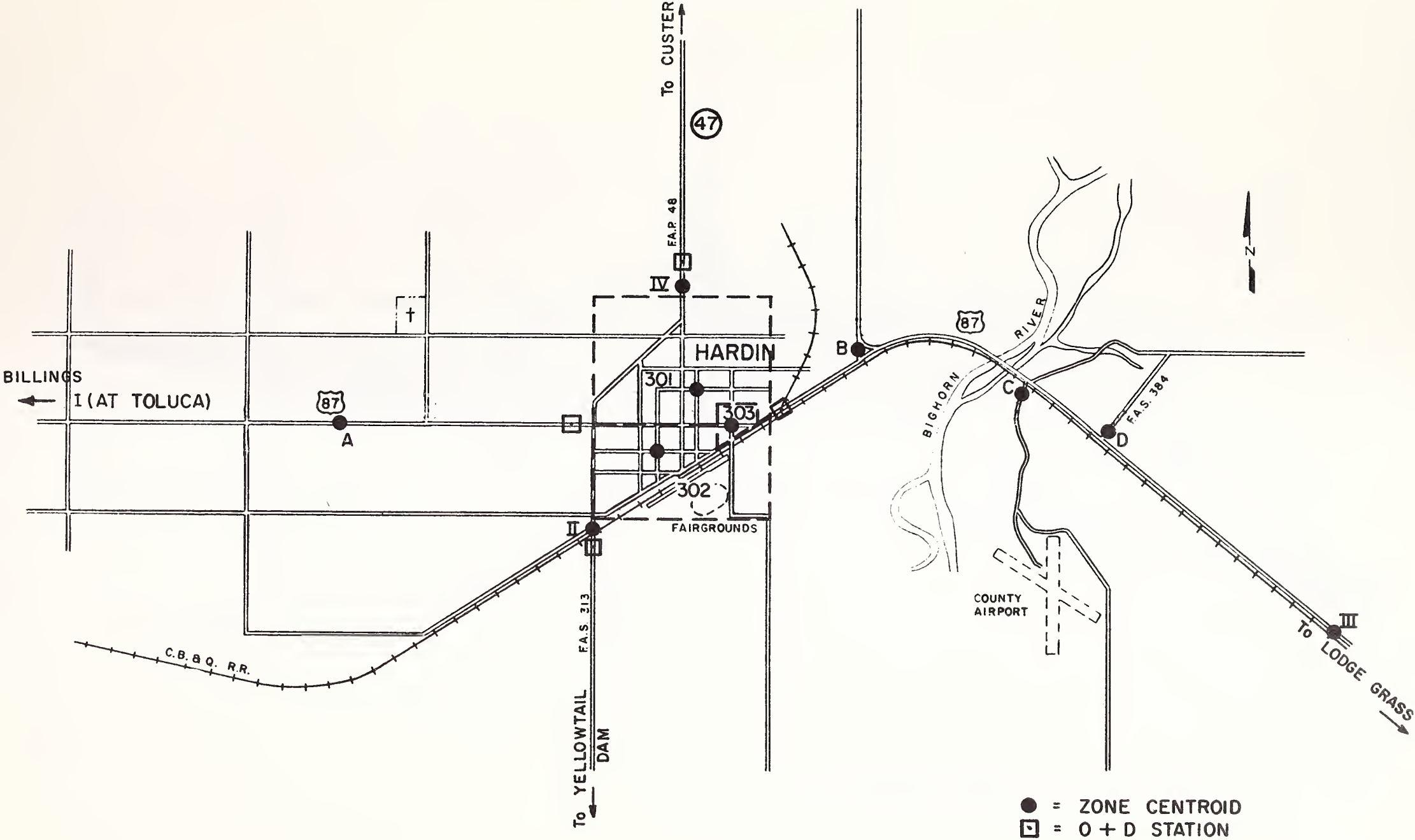
ZONE	A	B	C	D	301	302	303	I	II	III	IV
A	–										
B	12	–									
C	5	–	–								
D	23	–	–	–							
301	116	20	8	38	–						
302	47	8	3	15	–	–					
303	203	35	14	67	–	–	–				
I	80	23	10	45	431	176	758	–			
II	40	7	3	13	311	158	618	149	–		
III	208	36	15	70	796	439	1925	770	64	–	
IV	25	4	2	9	475	283	660	98	152	108	–
TOTAL	759	145	60	280	2195	1129	4280	2540	1515	4431	1861

1958 ZONE-TO-ZONE ADT

ZONE	A	B	C	D	301	302	303	I	II	III	IV
A	–										
B	7	–									
C	3	–	–								
D	14	–	–	–							
301	79	12	5	24	–						
302	32	5	2	10	–	–					
303	139	22	10	42	–	–	–				
I	40	15	7	28	167	68	294	–			
II	27	4	2	8	203	102	401	57	–		
III	141	22	10	44	301	165	725	300	41	–	
IV	18	3	1	5	309	184	428	39	99	41	–
TOTAL	500	90	40	175	1100	568	2061	1015	944	1790	1127

FIGURE I

ZONE MAP
PROJECT I-90-9(8) 471



1958 TRAFFIC DESIRE DIAGRAM
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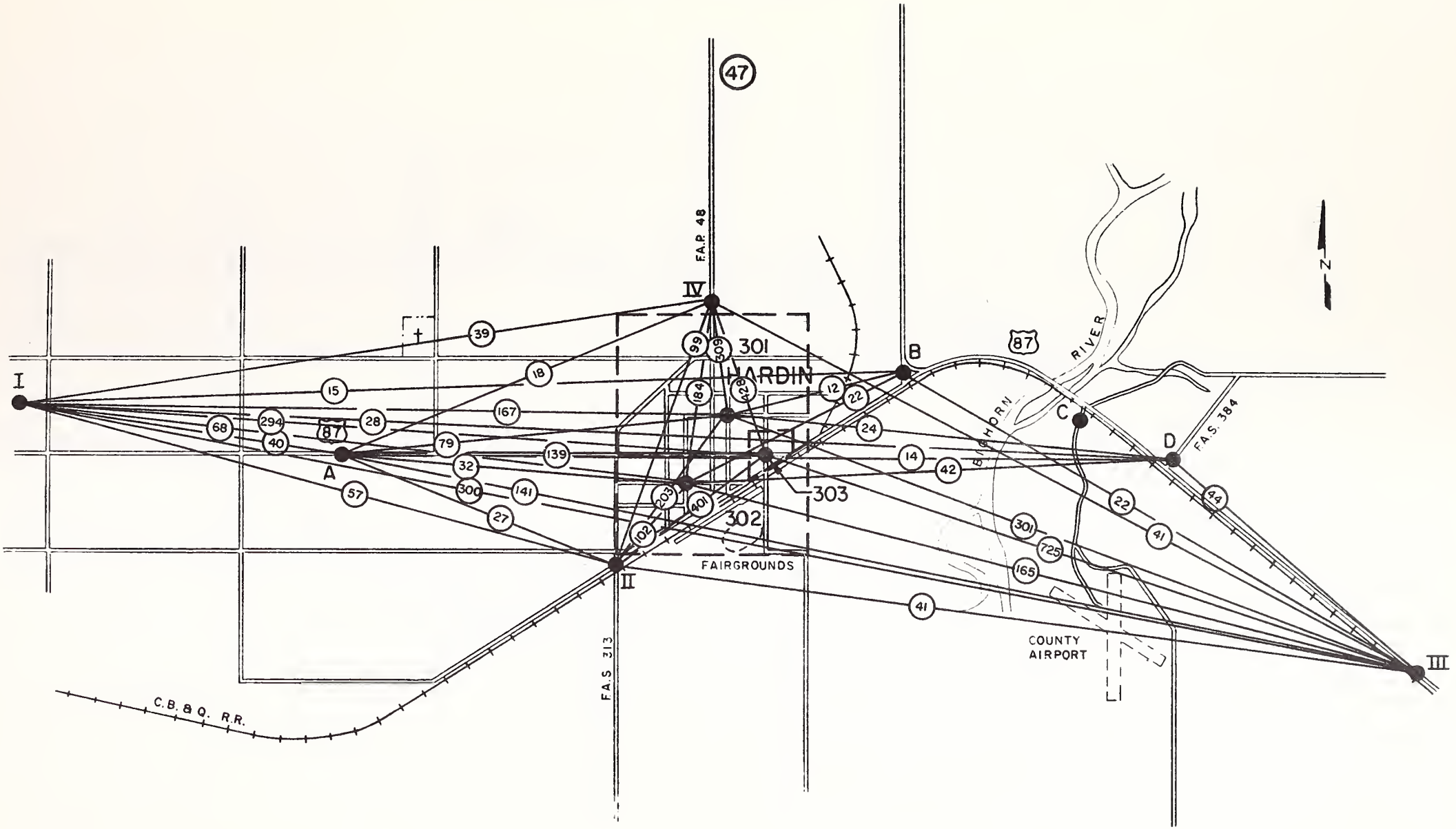


NOTE: DESIRE LINES OF 10 AND LESS NOT INDICATED.

ALTERNATE ROUTES
PROJECT I-90-9(8) 471

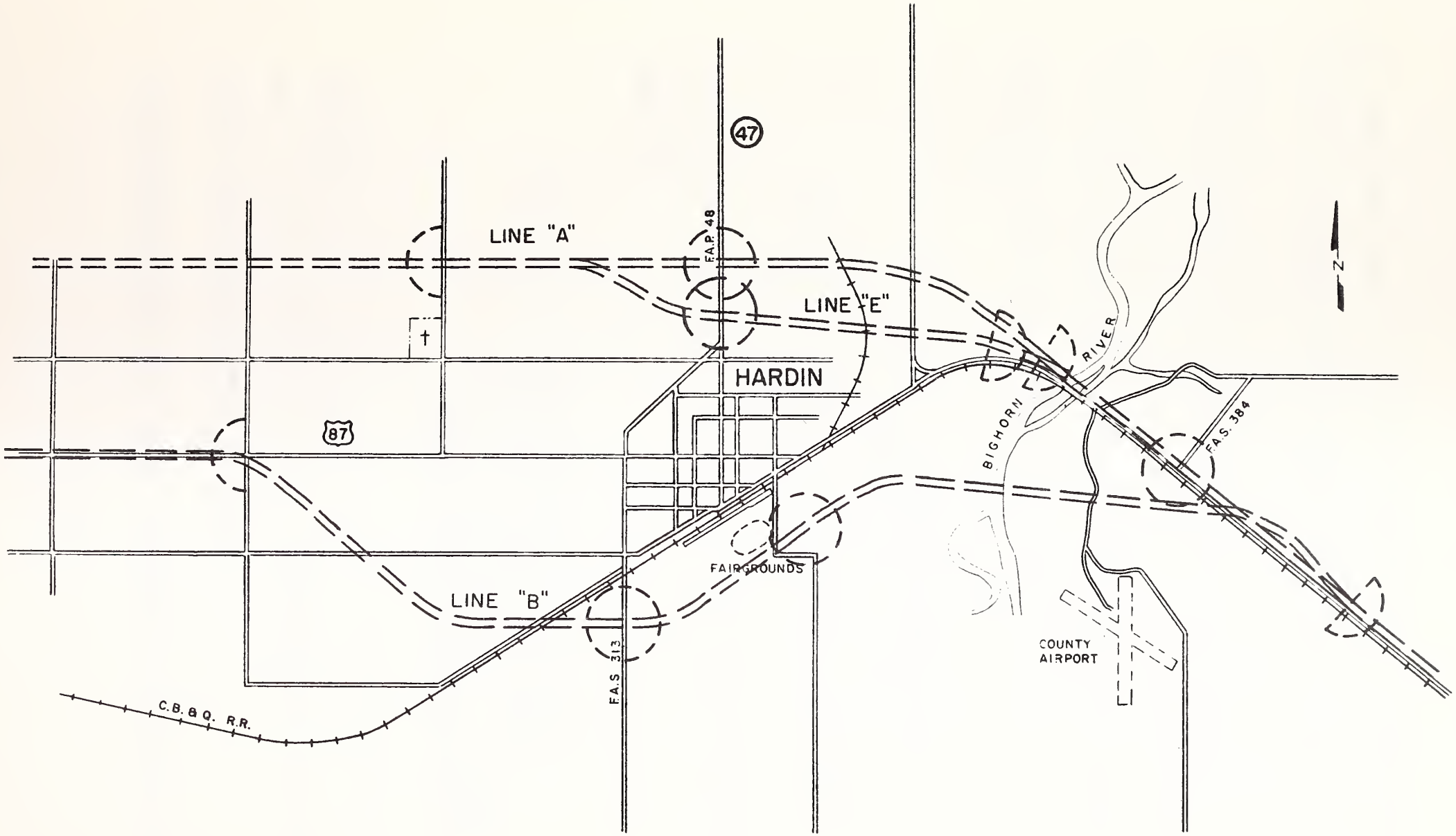


FIGURE IV

By comparing each interzone movement using existing streets with the "Freeway Users" trip or comparing "Freeway Haters", trips with "Freeway Users" trips, whichever is applicable, the differences in time and distance were obtained. Logic was used in each interzone movement so that distorted and unreasonable trips were not used. The following formulas were applied to find the percentage diversion of trips to freeways and ramps:

$$P = 50 + \frac{50(d + 1/2t)}{[(d - 1/2t)^2 + 4.5]^{1/2}}$$

Where p = Percent assignment to the Freeway
d = Distance saved
t = Time saved

or if $p < 50$ and $L < 2.0$ miles, the following modification is applied:

$$p_1 = p + (p-50) \times (1.5 - 0.75L)$$

Where p_1 = Modified percent assignment.
p = Original percent assignment.
L = Length of Freeway travel on Freeway routing minus length of Freeway travel on basic or existing routing.

Penalties of 0.1 mile and 0.5 minute were added for each ramp used in each interzone trip to compensate for circuitry of travel and slower speeds on ramps.

It should be noted that when a frontage road paralleled the

Interstate for a considerable distance and where there was a choice of routings, logically, the traffic was diverted to the Interstate routing.

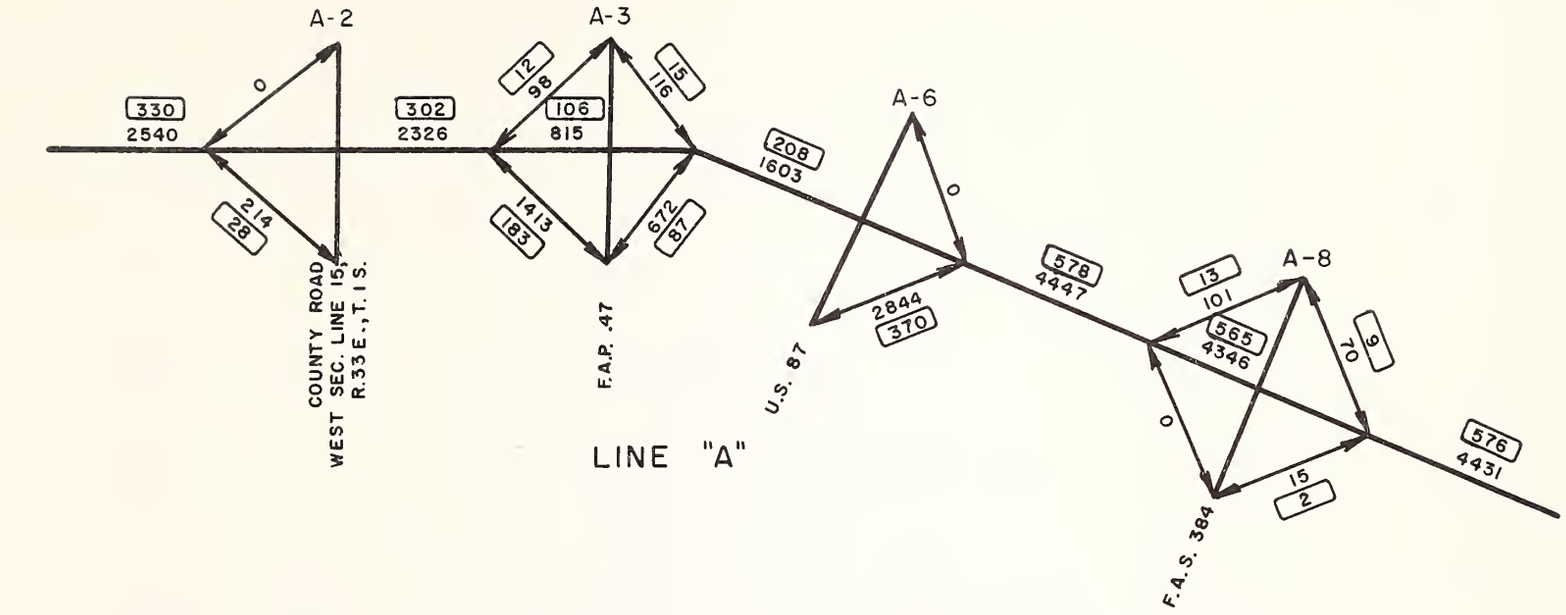
Summarizing the data thus obtained, flow diagrams of traffic on the Interstate and interchanges were prepared. These are shown on Figures V through XVII.

D. USERS' COST

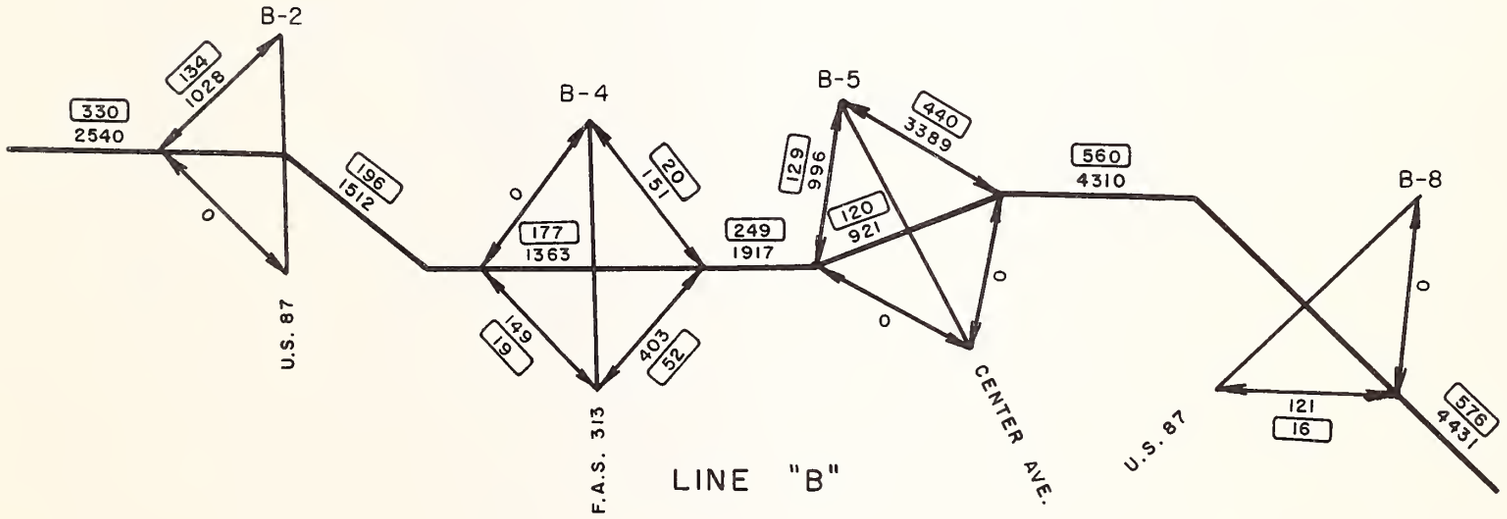
Mileages for the various speeds used on freeway, city, county, secondary and primary roads were tabulated. Unit prices of travel, adjusted for gradient, curvature and higher gasoline prices in Montana, were established with the aid of the AASHO publication entitled "Road User Benefit Analysis for Highway Improvements." The road users' costs were calculated for a 20 year period from 1965 to 1985. The capital recovery factor was based on 5% for 20 years. The road user unit prices are listed below:

Type of Facility	Operation	Grade - %	Cost per Mile
Interstate:			
4 lane, divided	Free	0-3	$.0936
4 lane, divided	Free	3-5	.0963
2 lane	Free	0-3	.0973
Primary - 2 lane	Normal	0-3	.1035
County Road - 2 lane	Gravel	0-3	.1250
City - 2 lane	Restricted	0-3	.1406

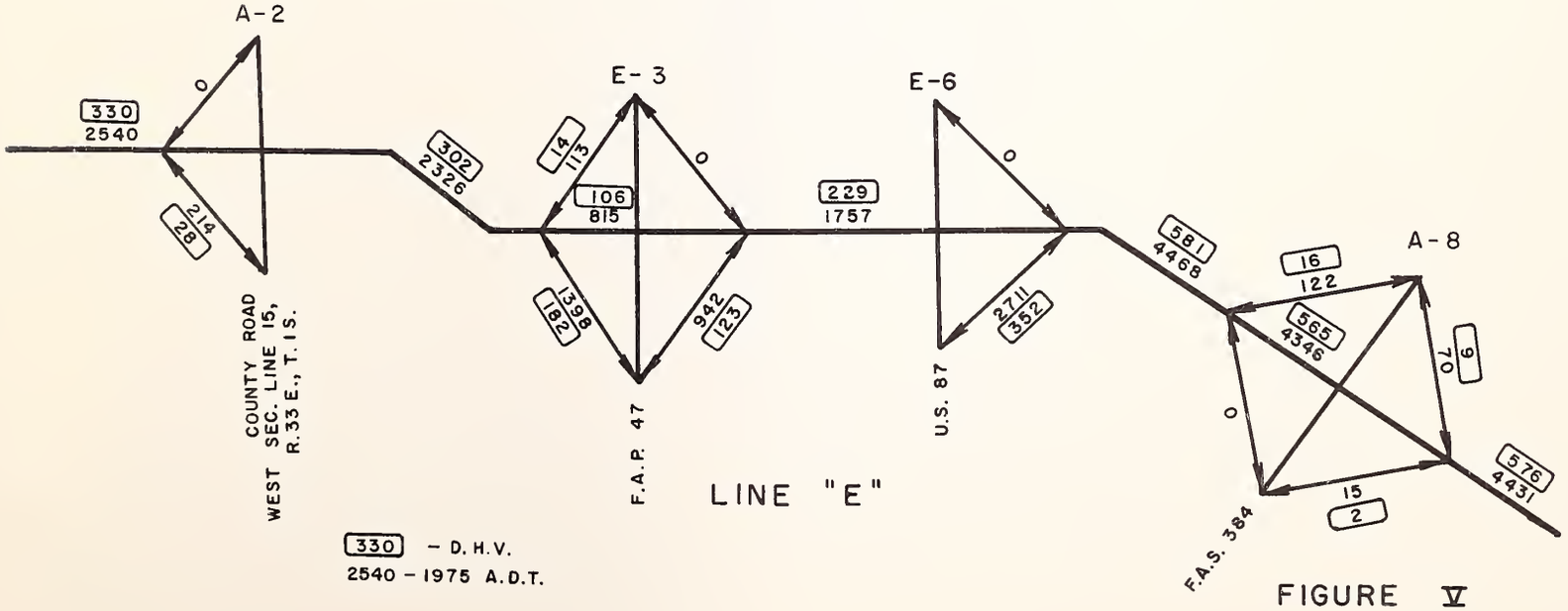
TWO-WAY AVERAGE DAILY TRAFFIC
PROJECT I-90-9(8)471



LINE "A"



LINE "B"

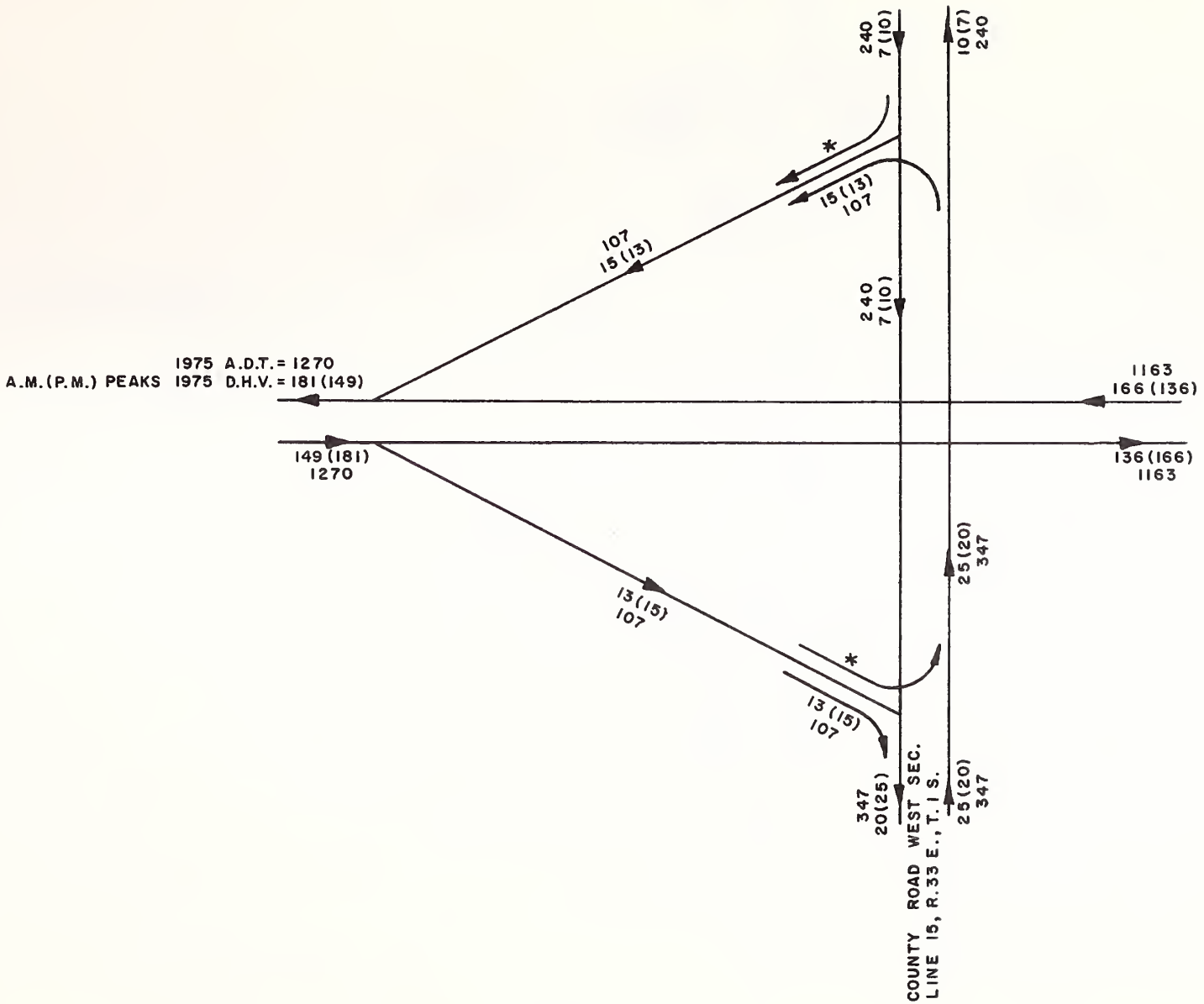


LINE "E"

330 – D.H.V.
2540 – 1975 A.D.T.

FIGURE V

A-2 INTERCHANGE LINE "A"
2025+00



* NOMINAL

FIGURE VI

A-3 INTERCHANGE LINE "A"
2100+00

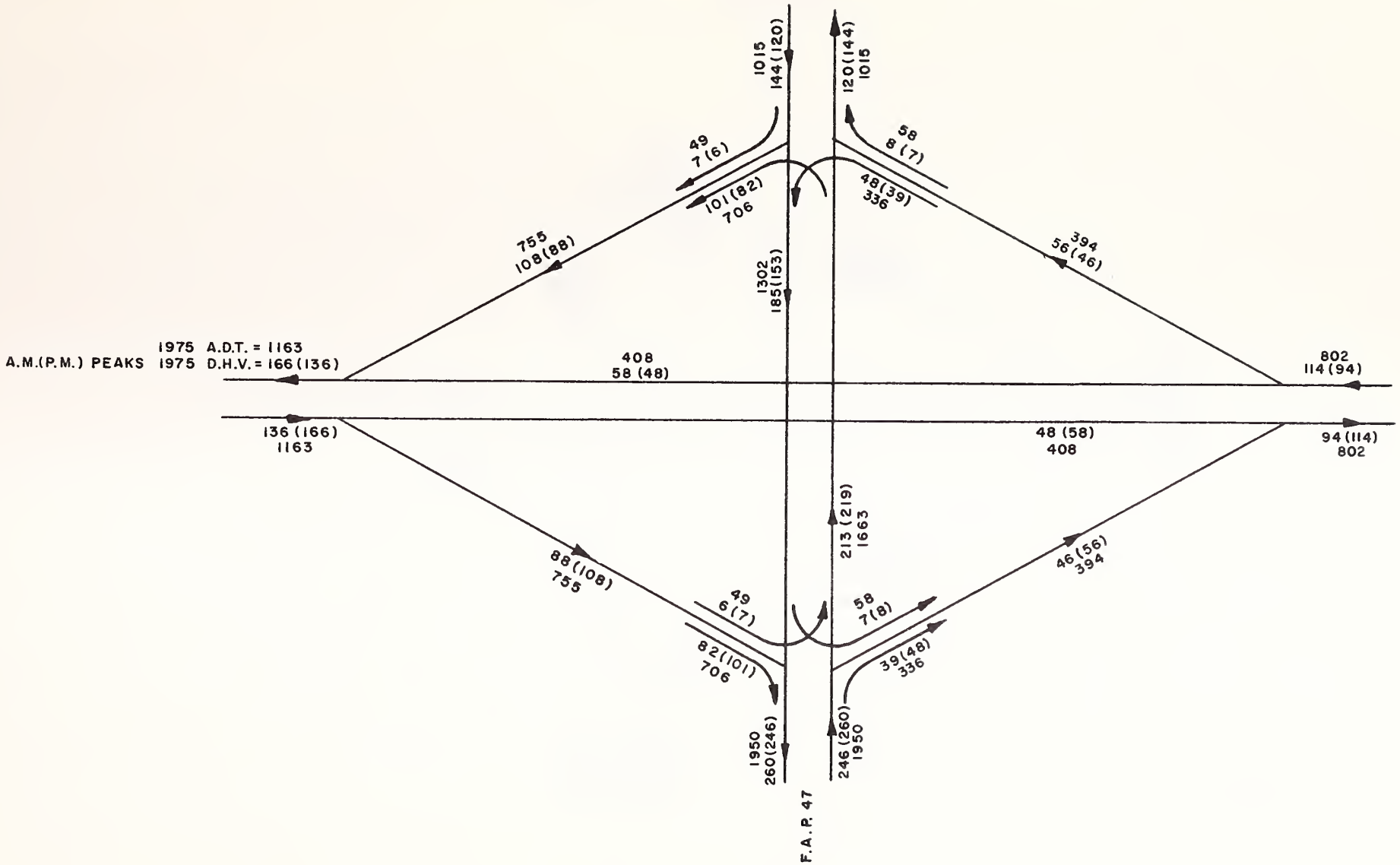


FIGURE VII

A-6 INTERCHANGE LINE "A"
2185+00

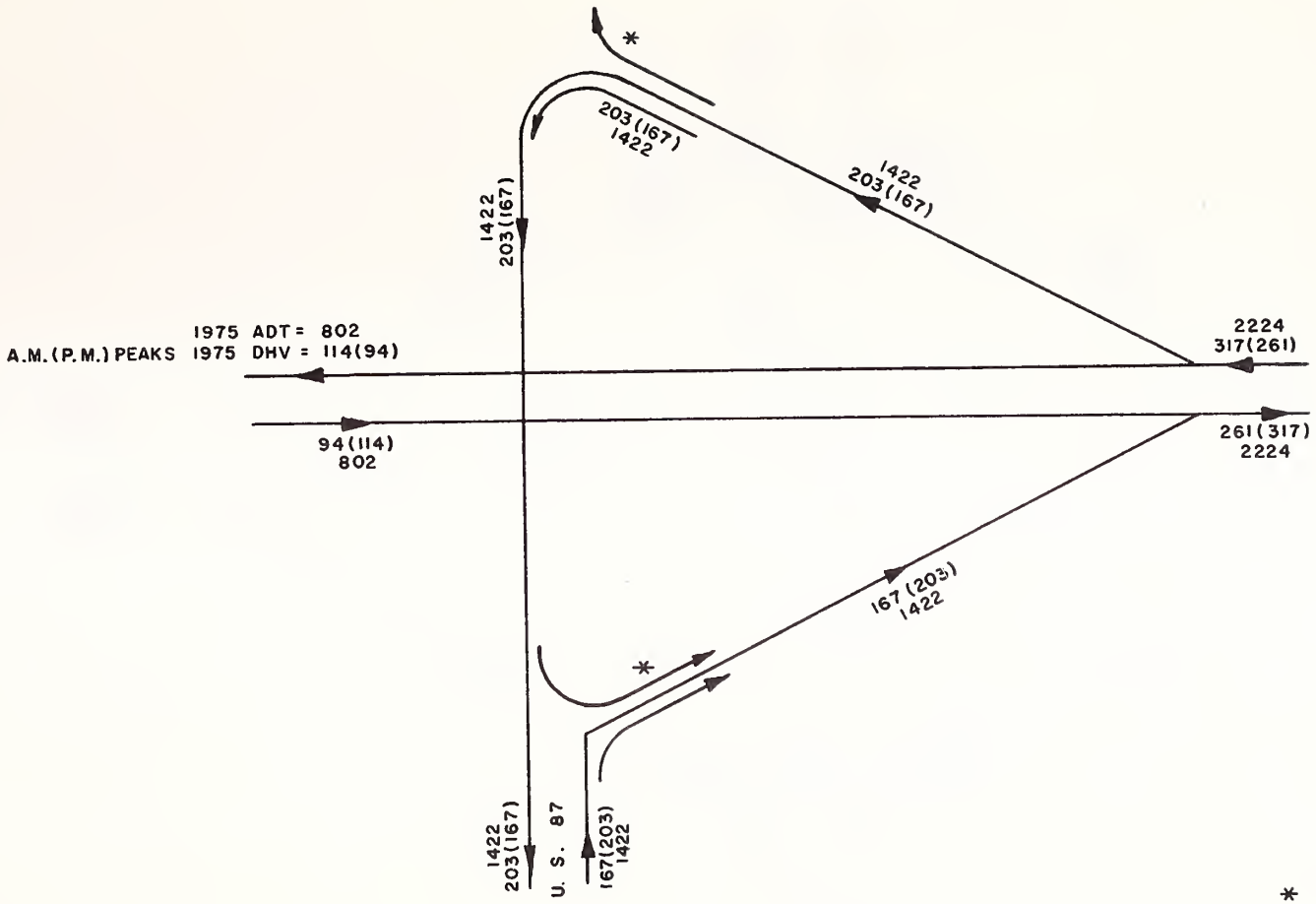


FIGURE VIII

A-8 INTERCHANGE LINE "A"
2243+50

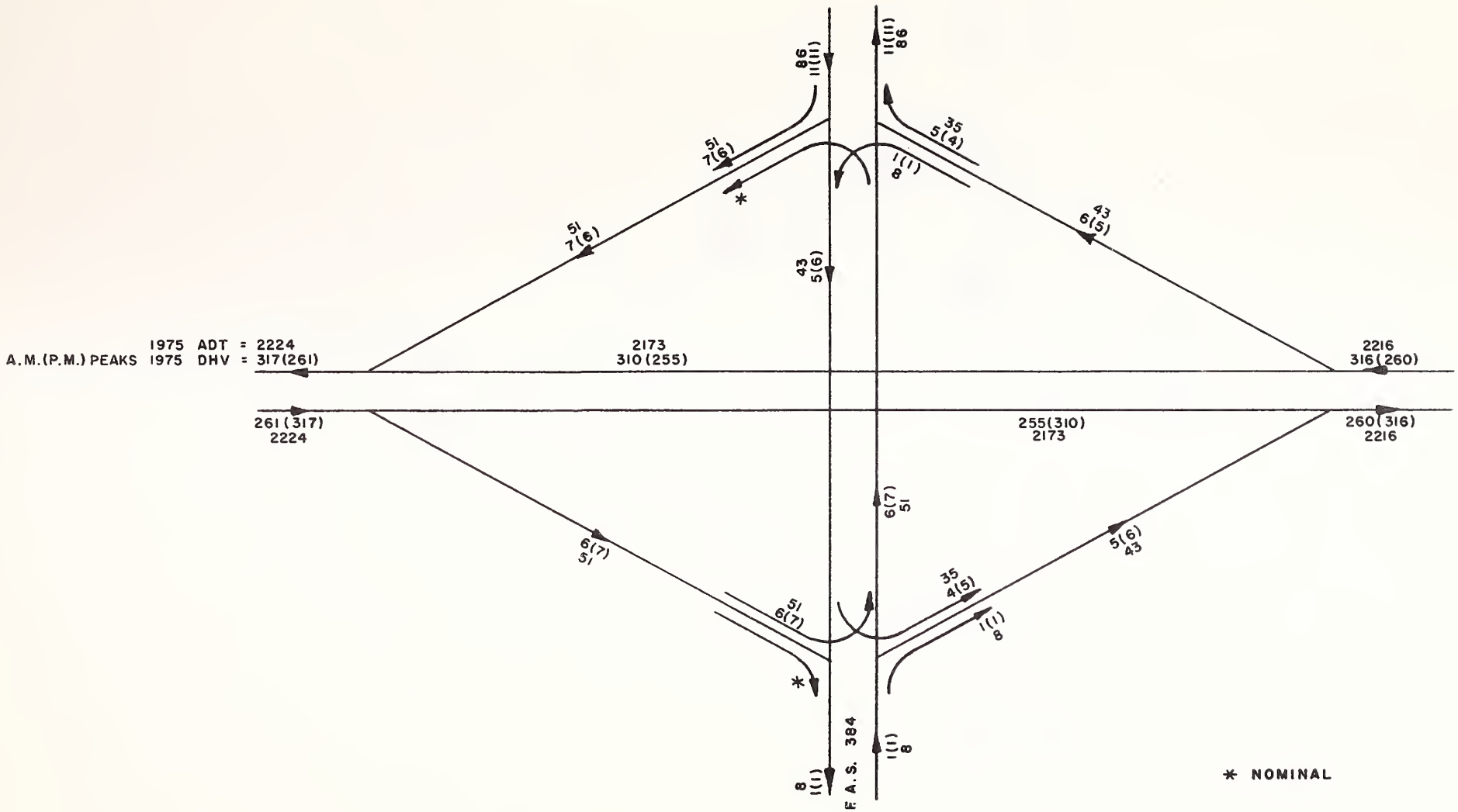


FIGURE IX

B-2 INTERCHANGE LINE "B"

1981+00

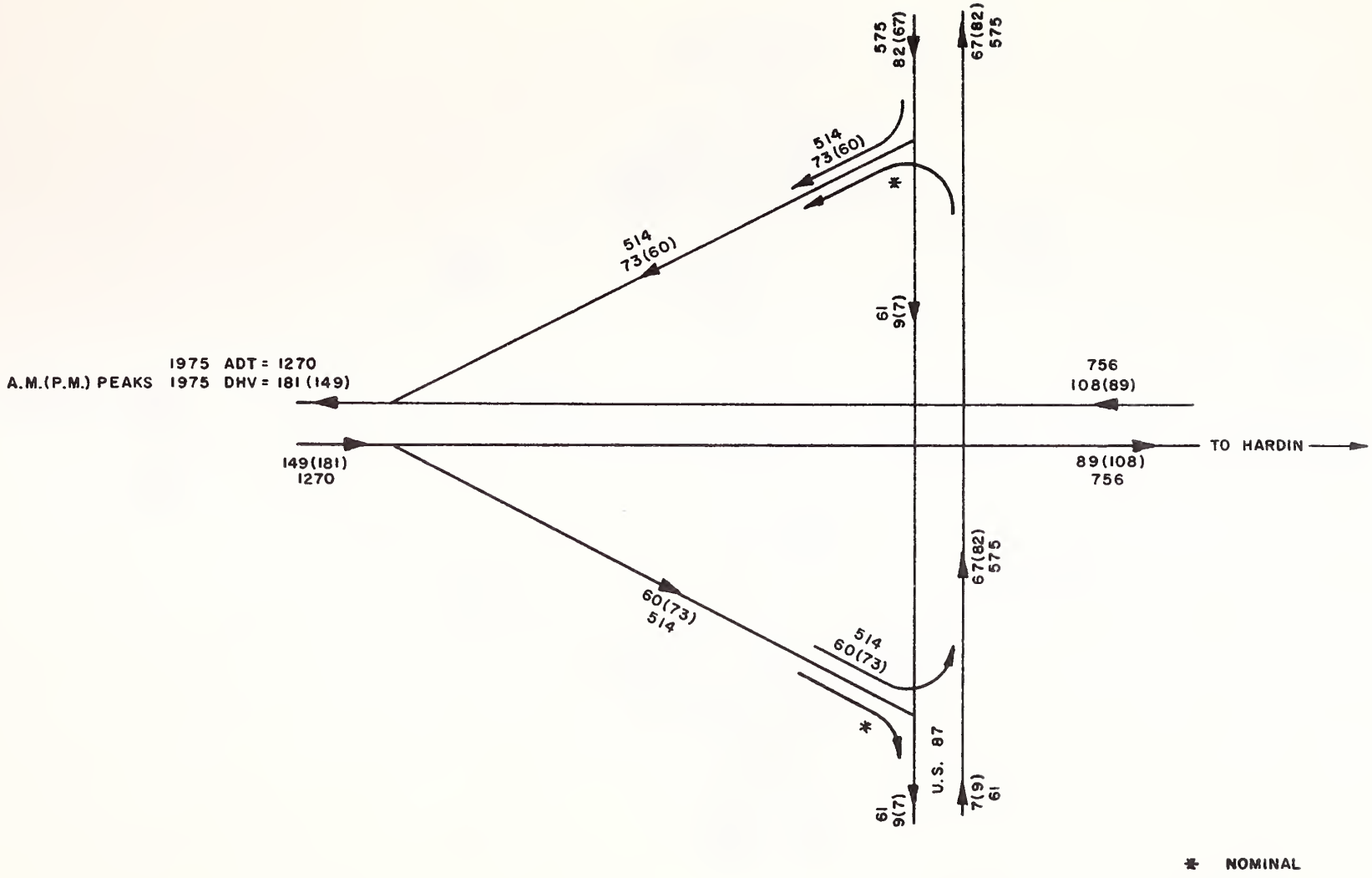


FIGURE X

B-4 INTERCHANGE LINE "B"
2095+00

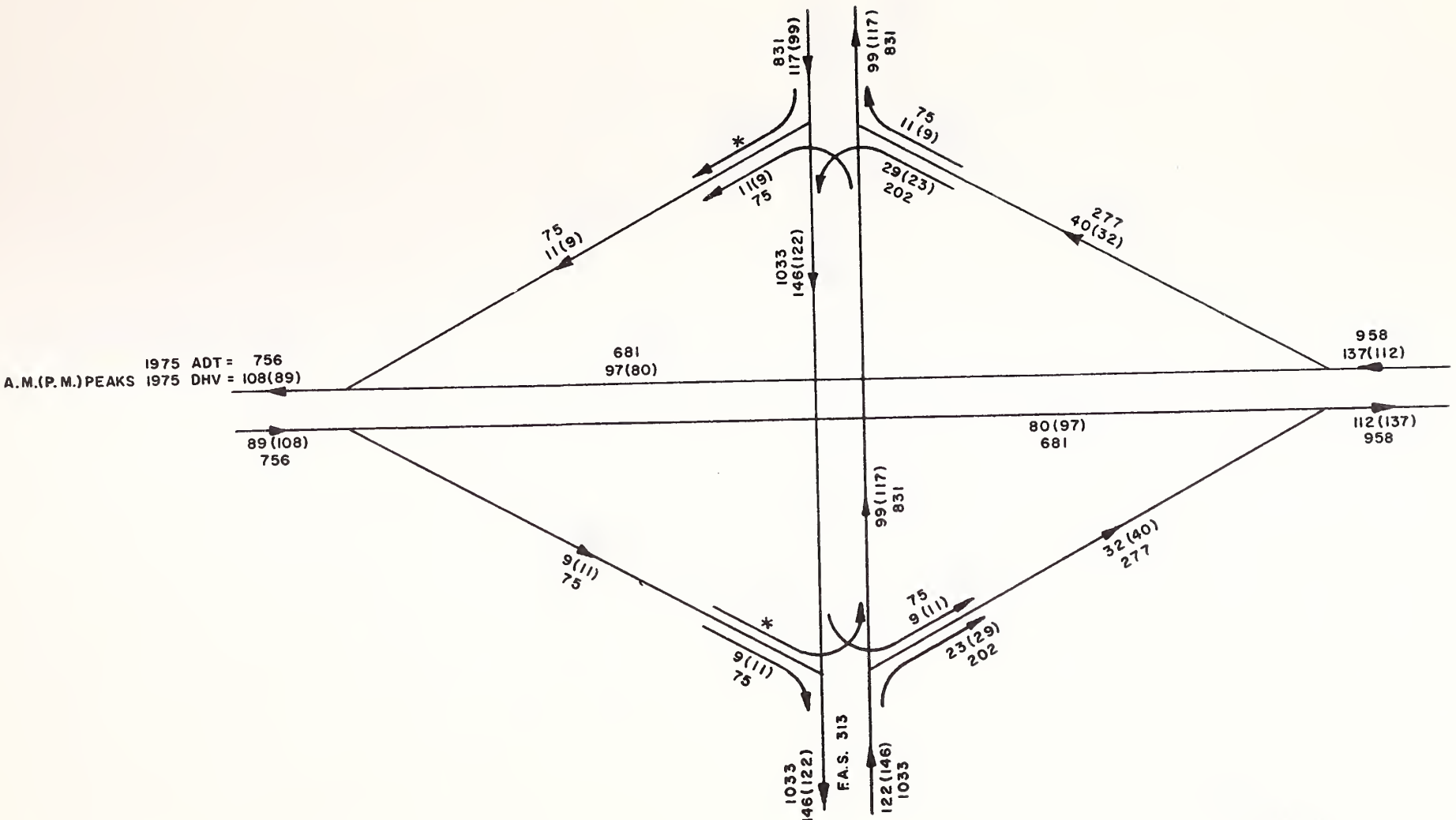


FIGURE XI

B-5 INTERCHANGE LINE "B"
2148+00

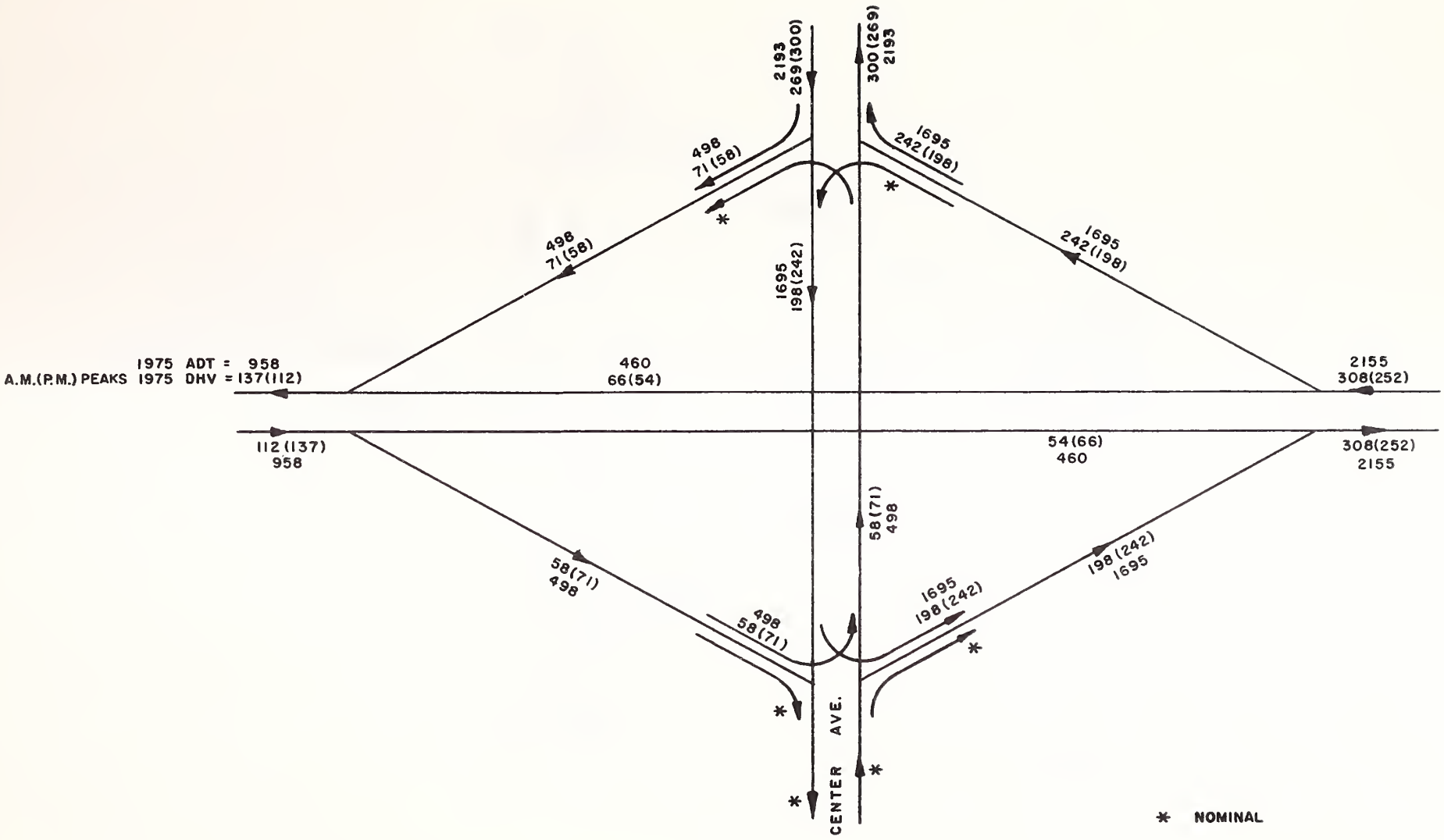


FIGURE XII

B-8 INTERCHANGE LINE "B"
2277+00

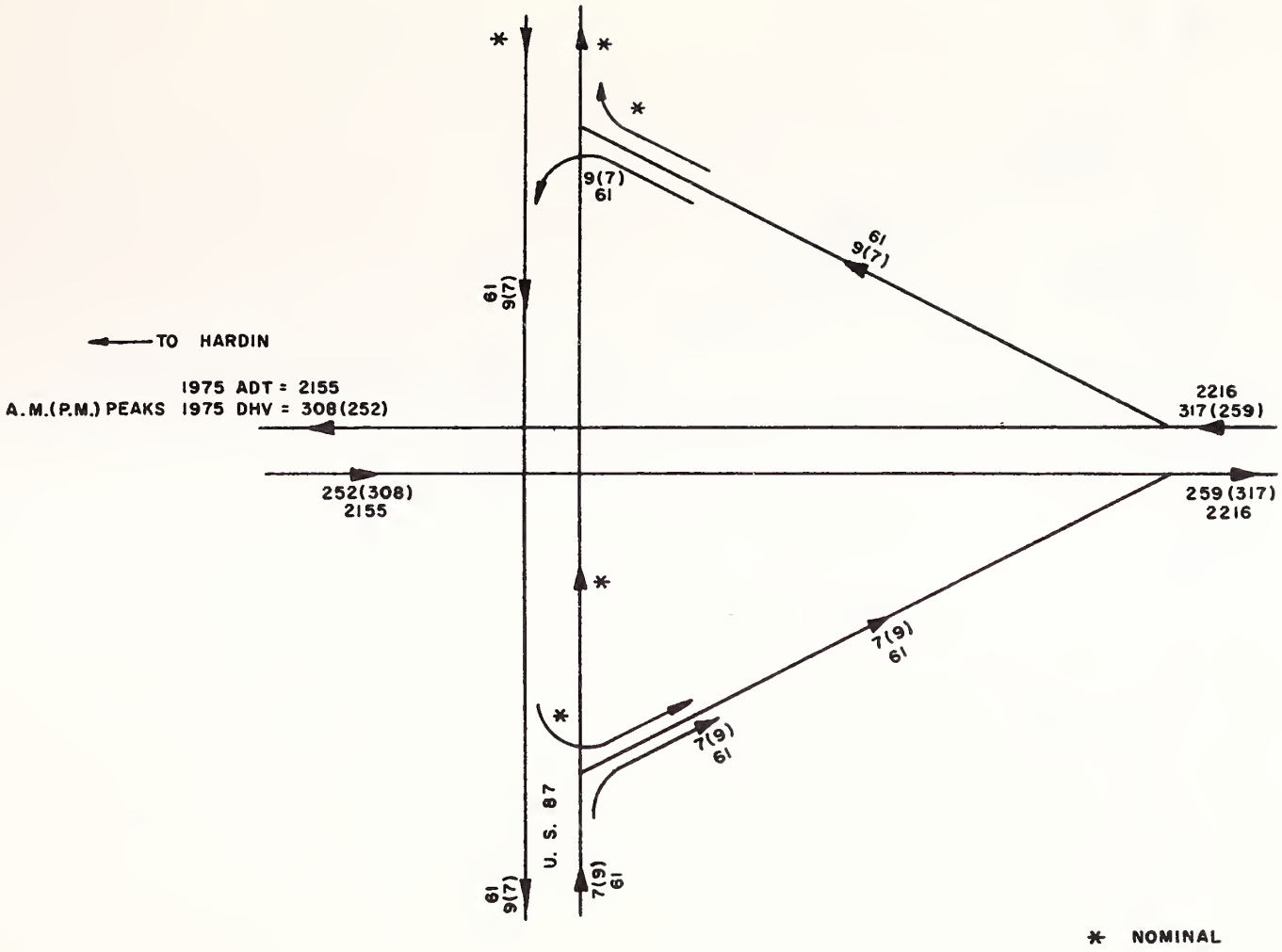
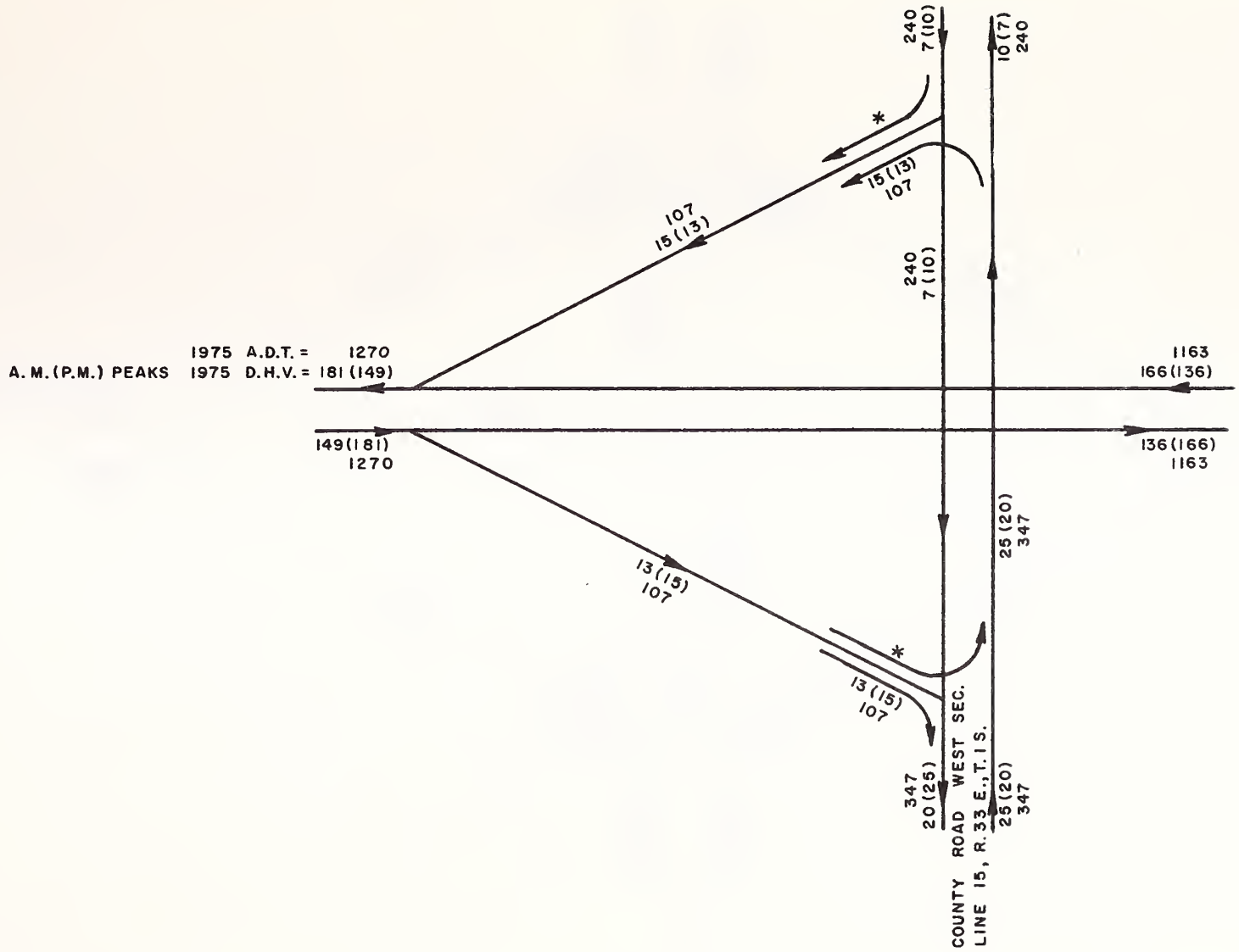


FIGURE XIII

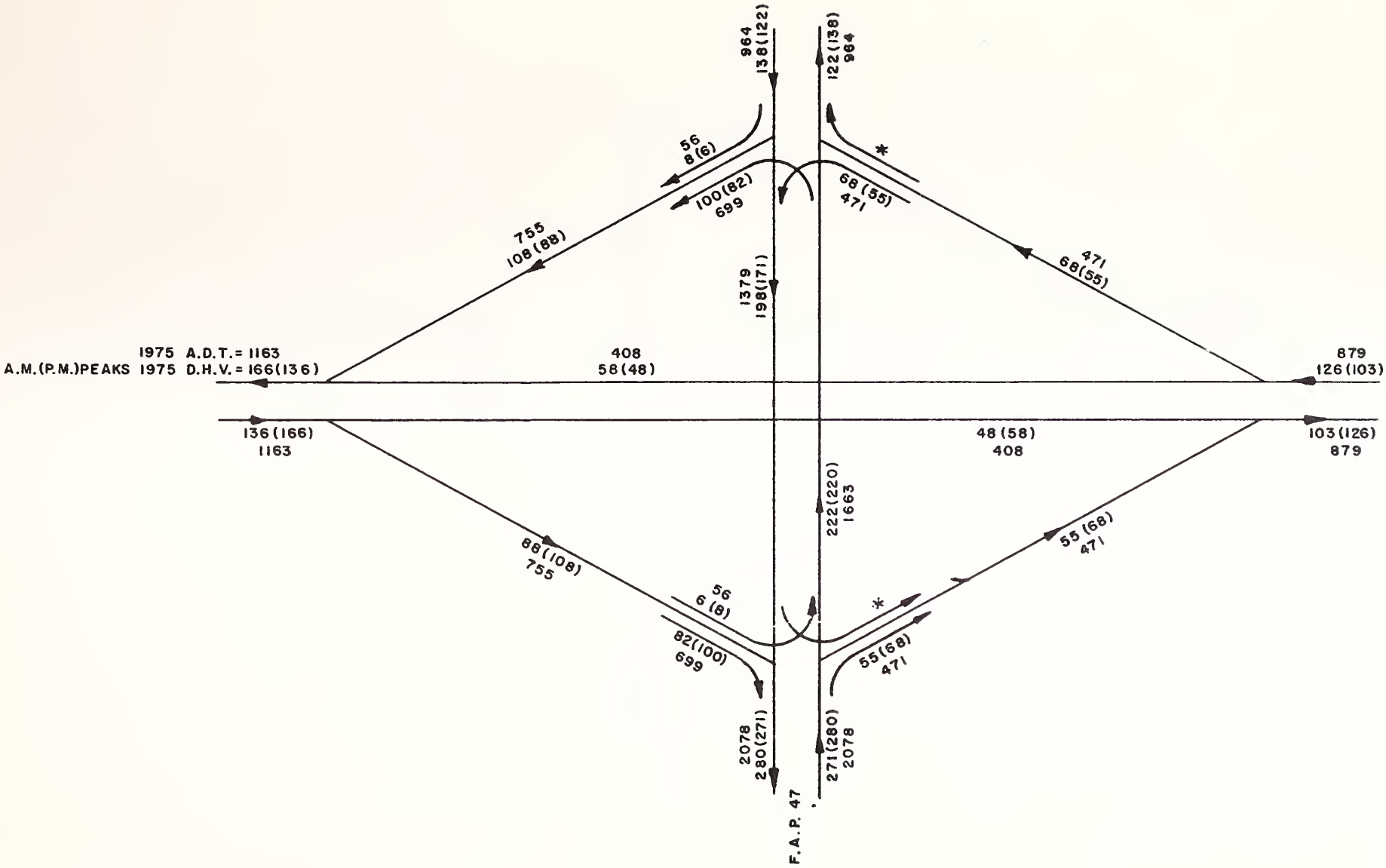
A-2 INTERCHANGE LINE "E"
2025+00



* NOMINAL

FIGURE XIV

E-3 INTERCHANGE LINE "E"
2104+50

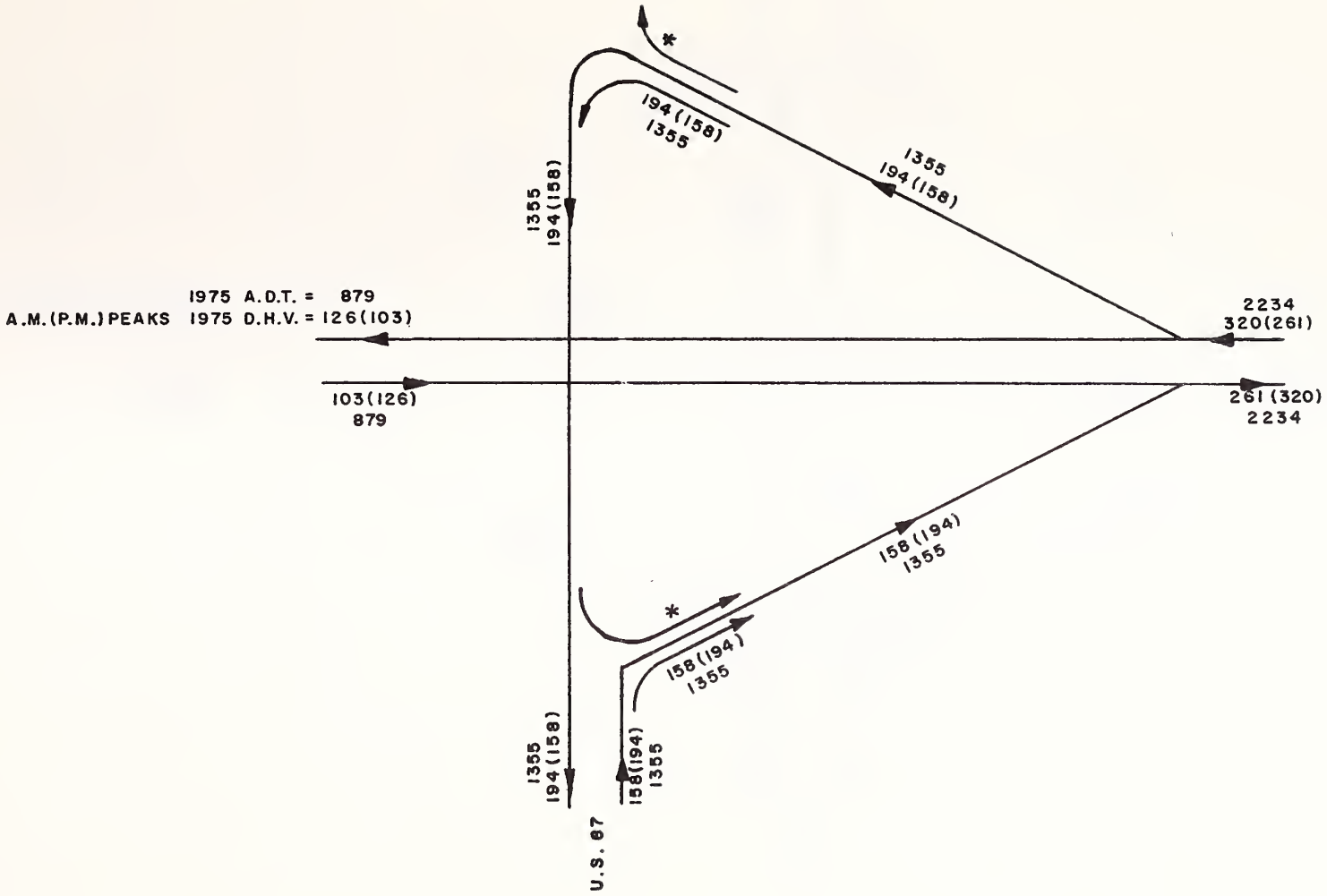


* NOMINAL

FIGURE XV

E-6 INTERCHANGE LINE "E"

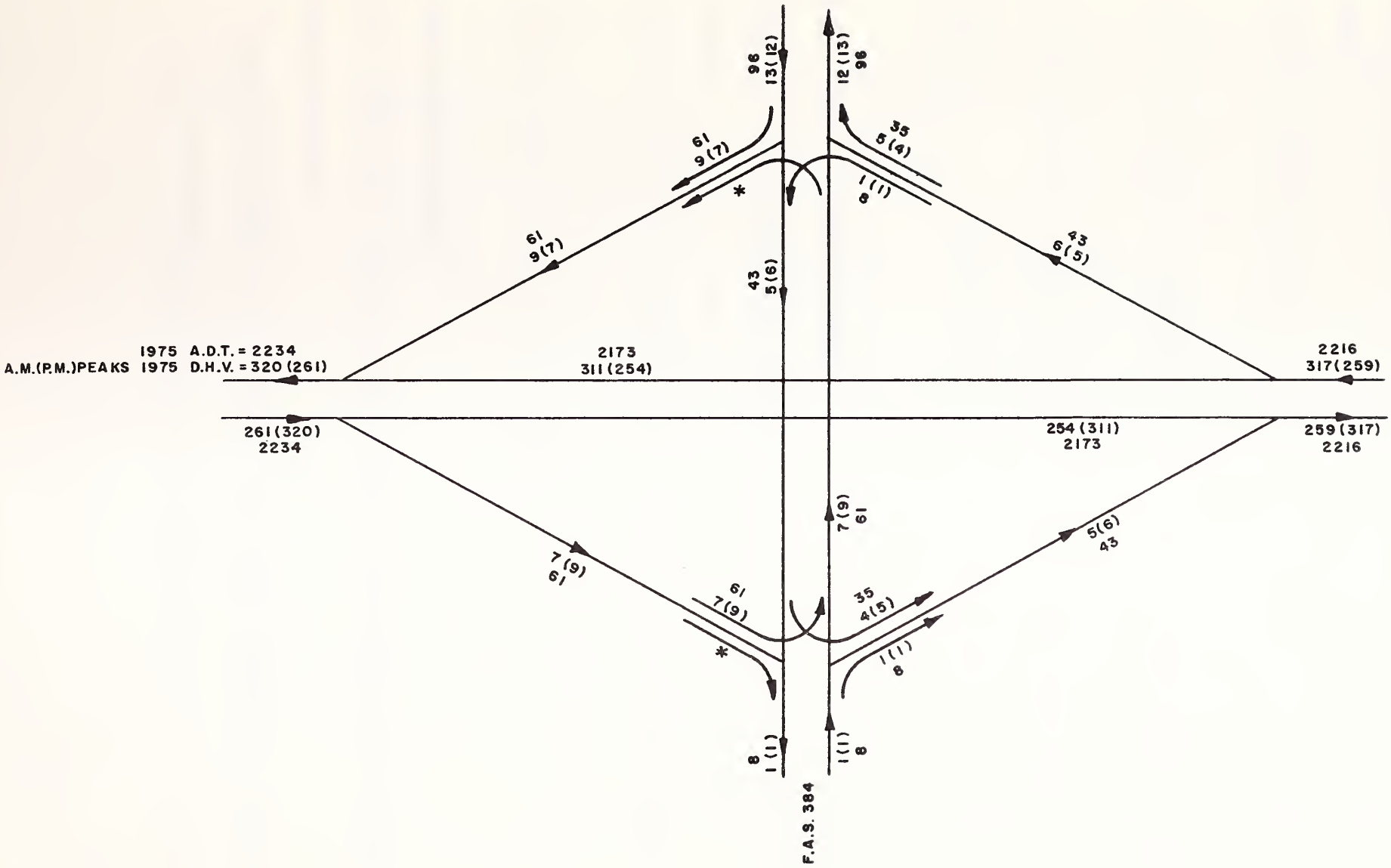
2170+00



* NOMINAL

FIGURE XVI

A-8 INTERCHANGE LINE "E"
2243+50



* NOMINAL

FIGURE XVII

The unit prices multiplied by the total mileage plus a penalty cost for an intersection delay (downtown stop light) established the operating cost. It is to be noted travel costs for the study area were totaled for all inter-zone movements in the area. Road users' costs combined with construction, maintenance and right-of-way costs determined the users' cost for each alternate. Summaries of these costs are shown on Table II in Part II of this report.

E. INTERCHANGE JUSTIFICATION

Table I indicates the annual savings by using the interchange locations indicated for the various alternates shown in the Plan Sheets 1-16 in the back of the report. Justification is shown for the interchanges which were questionable as to their value.

F. LANE REQUIREMENTS

The following criteria was used for determining laneage requirements:

1. Running Speed - In excess of 50 mph (based on information from Highway Commission speed studies in Montana).

TABLE I

INTERCHANGE JUSTIFICATION

Line	Interchange	Annual Operating Cost Savings	Annual Costs			Annual Excess of Savings over Costs
			Const.	Maint.	Sub-Total	
A	A-2 Station 2025+00	$ 16,140	*$2,957	$ 850	$ 3,807	$ 12,333
E	A-2 Station 2025+00	A Line justification sufficient.				
A	A-6 Station 2185+00	$135,110	$13,180	$2,000	$15,180	$119,930
E	E-6 Station 2170+00	A Line justification sufficient.				
A&E	A-8 Station 2243+50	$ 12,180	*$3,836	$1,600	$ 5,436	$ 6,744
B	B-2 Station 1981+00	$ 15,600	*$4,030	$1,200	$ 5,230	$ 10,370
B	B-4 Station 2095+00	$ 13,450	*$5,882	$1,600	$ 7,482	$ 5,968
B	B-8 Station 2277+00	(See note below) *				

NOTE: One hundred and twenty vehicles per day would be forced out of direction by six miles in order to use the Mitchell Road Interchange, or would be required to use a frontage road all the way to the interchange east of Hardin.

* Structure would be built regardless of interchange.

2. Capacity - Based on "Highway Capacity Manual", U. S. Department of Commerce, Bureau of Public Roads.

Six hundred passenger cars per hour (p. 46 of referenced Manual).

a. Correction with 12% trucks level terrain (p. 56 of referenced Manual).

600 x 0.89 = 534

b. Correction with 15% trucks level terrain (p. 56 of referenced Manual).

600 x 0.87 = 522

c. Correction with 12% trucks rolling terrain (p. 56 of referenced Manual).

600 x 0.75 = 450

3. Recommended Laneage for Alternates:

a. A Line

2 Lane Sta. 1530+00 to Sta. 2190+00
4 Lane Sta. 2190+00 to Sta. 2336+00

b. B Line

2 Lane Sta. 1530+00 to Sta. 2152+00
4 Lane Sta. 2152+00 to Sta. 2344+00

c. E Line

2 Lane Sta. 1530+00 to Sta. 2180+00
4 Lane Sta. 2180+00 to Sta. 2336+00

P A R T I I

ALTERNATE DESCRIPTIONS AND COST DATA

A. A LINE

The A Line plans are shown on Sheets 1-16 in the back of the report. Beginning at Station 1530+00 and proceeding east along a tangent to Station 1750+00, the A Line passes through rolling ranch land. Moderate cut and fill sections will be encountered in this region. As discussed later in the soils and geological section, the soils of this area are a problem due to their expansive nature. The problem as related to the soils, is held to a minimum by keeping the roadway high up on the hills to the north, where the soils are better than those in the lower elevations to the south. By cutting in the better soils and filling in the lower areas, a more stable subgrade can be built.

At Station 1584+00 and Station 1736+00, simple span drainage structures were utilized to take care of the drainage areas that cross the centerline. For estimating purposes, these structures were made comparable in size to the existing structures on U.S. 87 which serve the same drainage areas.

The only grade on the A Line that approaches three percent, in this section to the west of Hardin, is a 2.79 percent grade between Station 1690+00 and Station 1735+00.

From Station 1750+00 the line bears slightly north and is again a tangent to Station 2025+00. This location keeps the alignment in

the higher and better soils. The alignment traverses into the cultivated dry land farming at approximately Station 1840+00 which is on the bench west of Hardin. It is proposed that upon completion of the Yellow Tail Dam that this area will be irrigated by water furnished by that dam.

A grade separation for the county road was provided at Station 1919+00 to minimize long trips for farm machinery, farm cars and traffic moving to the northwest. The system of County Section Line roads will serve as frontage and access roads throughout this area.

At Station 2025+00 a half diamond is proposed. This interchange will be used to service the rural area west of Hardin served by the county roads and provide a more direct route to FAS 313 to the Yellow Tail Dam. It will eliminate out of the direction travel to these areas. The structure for this interchange would be required, to provide access for the area to the north, regardless of the interchange facility. Costs providing justification for the interchange are shown in Table I, Part I.

From Station 2025+00 to Station 2149+00, the alignment again goes due east along the midsection line to minimize property damage to the irrigated land. At Station 2037+00 it will be necessary to have a simple span structure to cross the Two Leggins Canal. The canal serves the irrigated area west of the City of Hardin. All lateral

ditches in the area are privately owned so that the final design plans will have to include restoration of any ditches disturbed by the construction of the roadway.

At Station 2100+00, a full diamond interchange is proposed. The interchange will service the area north of Hardin along FAP 47, as well as Hardin proper. Route 47 will afford a direct connection to proposed Interstate 94 to the north. No justification was deemed necessary for this interchange due to its location and the primary route it intersects.

From this interchange the alignment passes close to the north city limits of the City of Hardin and crosses the C.B. & Q. Railroad's north spur line. This location was chosen to pass as close to the city as possible without disturbing existing developments and allow for the continued expansion of the residential area already in progress. It would also cause fewer utility problems for the existing and future residential developments.

From Station 2149+00 to Station 2200+00, the alignment swings southeast to become parallel with and adjacent to the existing primary route U.S. 87.

At Station 2153+00 a grade separation is proposed. The grade separation would serve traffic movements between the area southeast of Hardin and the Holly Sugar Refinery. It would also allow for move-

ment of farm equipment across the interstate in the farming area between the Big Horn River and the City of Hardin.

From Station 2200+00 to the east end of the project at Station 2336+00, the alignment is parallel along the east side of existing U. S. 87. At Station 2185+00, Interchange A-6 is proposed. This facility will service traffic to and from the east desiring access to Hardin. It provides a direct route to the city and cuts off approximately one-half mile of additional travel for the public. Justification is shown in Table I, Part I.

All of the alignment from this interchange west is proposed as a two-lane facility. All alignment southeast of this interchange is proposed as a four-lane facility. Reasons and justifications for the laneages may be found in Part I, Traffic, of this report.

The alignment crosses the Big Horn River at Station 2210+00. This crossing, which is just downstream from the present bridge, is the most logical since the channel widens downstream and more expense would be necessary at other locations.

A full diamond interchange is proposed at Station 2243+50. Traffic from FAS 384 will be serviced by this interchange. It will eliminate considerable frontage road travel or out-of-direction travel for traffic east and west bound. The separation structure

would be required regardless of the fact that ramps were included. Justification for this interchange is shown in Table I, Part I.

From Station 2217+00 to Station 2336+00, a frontage road is proposed in order to serve property owners on the east side of U.S. 87. These property owners would travel the frontage road to Interchange A-8 and would then either enter the interchange or U.S. 87 for directional travel.

The grade line was held comparatively high throughout this area to protect the interstate from flooding and also to keep above the high water table as described in the soils and geological section.

U.S. 87 will be left in place connected to the existing frontage road along the west side of the present Interstate 90 in order to serve the property on the west side of the C.B. & Q. Railroad.

B. B LINE

The B Line plans are shown on Sheets 1-16 in the back of the report.

From Station 1530+00 to the east, the B Line and the A Line have a common alignment to Station 1800+00. The coincidental alignment in this area was chosen due to the poorer soil conditions to the south. At this point the B Line swings to the southeast

to become parallel to U. S. 87 some 3-1/2 miles west of the City of Hardin. In order to maintain traffic throughout this farming area, a grade separation is proposed for the county road at Station 1926+00. This alignment allows present U.S.87 to serve as an independent roadway west to Toluca.

A half-diamond interchange is proposed at Station 1981+00 for traffic from the west to and from Hardin and to provide direct access to the rural irrigated area serviced by the three county roads in the area (Zone A) west of Hardin. Justification is shown in Table I, Part I. The separation structure should be built for this area regardless of the interchange facility.

Proceeding east from the interchange, the alignment swings southeast to pass south of the City of Hardin. This location was chosen rather than one closer to town due to the amount of culture and the advantage of better grade possibilities by following the natural draw that leads down from the bench.

At Station 2180+00 it will be necessary to have a simple span structure to cross the Two Leggins Canal. Once across the canal, the land becomes irrigated farm land and continues to the crossing of the Big Horn River at Station 2210+00. The alignment through this irrigated land was held as close to the southern limits of Hardin as possible. The limiting factors in locating the line

included the C. B. & Q. Railroad, the proposed 1,000 foot extension of the existing runway for the airport, and the fairgrounds.

A diamond interchange is proposed at Station 2095+00 to serve traffic from the Yellow Tail Dam area and the intervening rural area. Present plans indicate that recreational facilities will be developed in the Yellow Tail Dam area. Use of this interchange by traffic desires in the east and west direction from FAS 313 will eliminate a crossing of the main line tracks of the C. B. & Q. Railroad to the north. The structure for this crossing should be built regardless of the interchange facility. Justification for this interchange is shown on Table I, Part I.

The City of Hardin, particularly the central business district, will be serviced by the proposed diamond interchange at Station 2148+00. One disadvantage will be the increased traffic to and from the interstate crossing the main tracks of the C. B. & Q. Railroad to the north. Due to its location and traffic assignment, no justification was deemed necessary.

The line heads northeast from this interchange to the crossing with the Big Horn River. The crossing was selected after considerable study of the shale bluff. Soils and geologic information indicate this to be a feasible river crossing. At this

crossing the river is eroding the shale bluff to the east so that adequate protection would be required for the east abutment of the bridge.

The grade required for cutting through the bluff east of the Big Horn River is 4% and because of the truck traffic and the D.H.V. the interstate would require four lanes of roadway in order to properly accommodate the traveling public. Justification for the laneage can be found in Part I - Traffic.

A frontage road will be required from Station 2148+00 to Station 2183+00 to serve property owners who is the past had access to their property from the north of the B Line.

After ascending the bluff, the alignment is crossed by a grade separation structure at Station 2233+00. This crossing provides access to the airport atop the bluff.

Descending from the bluff the alignment crosses over the C. B. & Q Railroad and existing U. S. 87, thence swings southeast parallel to existing U. S. 87 to connect with the existing Interstate 90.

The alignment passes within approximately 1,500 feet of the airport atop the bluff but will not restrict use of the airport in any way.

A half-diamond interchange is proposed at Station 2277+00 to connect to U.S. 87 and enable traffic from FAS 384 to utilize the interstate. This will eliminate considerable out-of-direction travel or frontage road travel for the traffic to and from the east. The grade separation over the C. B. & Q. Railroad and U.S. 87 would be required regardless of whether the ramps were built. Justification is shown for this interchange in Table I, Part I.

A frontage road will be required to serve the property east of the interchange and will be constructed on the east side of the interstate from Station 2275+00 to Station 2344+00. A short segment of frontage road will be required to connect existing U.S. 87 with the frontage road along the west side of the present Interstate 90.

C. E LINE

The E Line plans are shown on Sheets 1-16 in the back of the report.

The E Line has the same alignment as the A Line from Station 1530+00 to Station 2050+00. At this point, the E Line swings southeast in an effort to better serve Hardin. This alignment cuts some irrigated farmland diagonally, but the attempt was made to hold damage to separated properties to a minimum.

The full diamond interchange at Station 2104+50 will service the area north of Hardin along FAP 47, as well as Hardin proper. Route 47 will afford a direct connection to proposed Interstate 94 to the north. No justification was deemed necessary for this interchange due to its location and the route it intersects.

From the interchange east to approximately Station 2115+00 this alternate will cause damage to improved properties and sever a developing residential area from the remainder of Hardin. Every attempt was made to minimize this damage.

At Station 2146+00 the alignment crosses the C. B. & Q. Railroad and at Station 2157+00 a county road is crossed with a grade separation. This grade separation will allow traffic traveling between the area southeast of Hardin and the Holly Sugar Refinery to pass under the Interstate.

A half-diamond interchange is proposed at Station 2170+00 with existing U.S. 87. This facility will service traffic to and from Hardin from the east. It provides a more direct route into the city and cuts off approximately 1/2 mile of additional travel for the public. Justification is shown in Table I, Part I.

From Station 2180+00 west, a two-lane facility is proposed and to the east a four-lane section is proposed. Justification for

the laneage can be found in Part I - Traffic of this report.

Beyond the interchange the alignment heads southeast and becomes parallel to U.S. 87 at Station 2200+00. It then has a common alignment with A Line to the end of the project where it connects with existing Interstate 90.

D. ESTIMATING PROCEDURES

1. Grading Quantities

The Montana Highway Commission furnished aerial maps with a horizontal scale of 1" = 400' and a 10' contour interval. This mapping was used as a basis for cross sections which were taken at appropriate intervals. End areas and volumes were then calculated.

2. Drainage

The cost of drainage structures 72" in diameter and under were estimated as an average cost per mile from figures furnished by the Montana Highway Commission for the year 1959. The 1959 costs were adjusted to present by using the Engineering News Record Index of June 20, 1963. Larger drainage structures were computed separately.

3. Surfacing

Surfacing costs were estimated by the use of cost-per-mile of roadway and updated to the present.

4. Structures

All structures were estimated by use of the Deck Area Method, with allowances for different site problems.

5. Interchanges

The interchange costs were estimated after the studies as to type and after general geometrics were completed. These costs are based on typical interchange costs for the particular type of interchange as constructed by the Montana Highway Commission and include the guard rail, curbs, and signing. The structures for the interchanges were estimated separately.

6. Right-of-Way Costs

Right-of-way costs were furnished by the Montana Highway Commission from ownerships furnished by this firm, and include only the cost of the acreage taken. However, it is expected that damages will be very nearly the same for all lines.

7. Summary of Total Costs

An interest rate of 5% was used for this study. The number of years of average life for each item of construction cost is shown on Table II. Maintenance costs for the various road types are shown on Table II. Costs of travel on the different types of roads are shown in Part I - Traffic.

Individual bridge costs are tabulated in Table B-I of Part III - Bridges.

When double maintenance is shown on Table II, the costs were prorated into the total to compensate for bad soil conditions encountered at the west end of the project.

Table II that follows gives the summarized total costs for each alternate.

TABLE II

ANNUAL ROAD USERS', CONSTRUCTION, R.O.W. AND MAINTENANCE COSTS

LOCATION	ITEM	ESTIMATED LIFE YEARS	TOTAL COST DOLLARS	*K	ANNUAL COST DOLLARS
"A"	Base, Surfacing etc.	20	$1,369,293	0.0802	$109,817.30
	Grading & Drainage	40	831,563	0.0583	48,480.12
	Major Structures	50	1,637,814	0.0548	89,752.21
	Right of Way	50	202,700	0.0548	11,107.96
	Maintenance: Interstate 4 Lane - 2.671 Miles @ $3000/Mile				8,013.00
	Interstate 2 Lane - 12.595 Miles @ $2500/Mile **				31,487.50
	Primary 2 Lane - 15.348 Miles @ $1500/Mile				23,022.00
	Frontage 2 Lane - 3.826 Miles @ $500/Mile				1,913.00
	Interchange Ramps - 2.272 Miles @ $1500/Mile				3,408.00
	Operating Cost				2,617,525.62
				Total	$2,944,526.71
"B"	Base, Surfacing etc.	20	$1,459,326	0.0802	$117,037.95
	Grading & Drainage	40	1,195,422	0.0583	69,693.10
	Major Structures	50	1,767,362	0.0548	96,851.44
	Right of Way	50	93,300	0.0548	5,112.84
	Maintenance: Interstate 4 Lane - 3.769 Miles @ $3000/Mile				11,307.00
	Interstate 2 Lane - 11.846 Miles @ $2400/Mile ***				28,430.40
	Primary 2 Lane - 15.348 Miles @ $1500/Mile				23,022.00
	Frontage 2 Lane - 3.011 Miles @ $500/Mile				1,505.50
	Interchange Ramps - 2.272 Miles @ $1500/Mile				3,408.00
	Operating Cost				2,549,775.58
				Total	$2,906,143.81
"E"	Base, Surfacing etc.	20	$1,372,496	0.0802	$110,074.18
	Grading & Drainage	40	829,783	0.0583	48,376.35
	Major Structures	50	1,624,913	0.0548	89,045.23
	Right of Way	50	219,950	0.0548	12,053.26
	Maintenance: Interstate 4 Lane - 2.879 Miles @ $3000/Mile				8,637.00
	Interstate 2 Lane - 12.310 Miles @ $2500/Mile **				30,775.00
	Primary 2 Lane - 15.348 Miles @ $1500/Mile				23,022.00
	Frontage 2 Lane - 3.826 Miles @ $500/Mile				1,913.00
	Interchange Ramps - 2.272 Miles @ $1500/Mile				3,408.00
	Operating Cost				2,624,509.31
				Total	$2,951,813.33

* K = CAPITAL RECOVERY FACTOR ** Includes 3.649 Miles of Double Maintenance
*** Includes 3.031 Miles of Double Maintenance

P A R T I I I

BRIDGES

A. GENERAL

Bridge investigations were performed on all sites for each line study. As the purpose of this report was to determine the most feasible route for Interstate 90, these investigations were confined in extent to determine relative total bridge costs only. Since the type and number of crossings were approximately the same for each line, no attempt was made to determine the most economical structure type or to evaluate other details which would not affect the relative total costs.

Sheet No. 16 of the plans illustrates the basic layout criteria used in determining bridge widths and approximate lengths. Total estimated bridge costs are tabulated in Table B-1. The estimated cost per square foot was varied to allow for heavy skew angles, excessive height and other unusual factors which would affect the bridge cost.

B. BIG HORN RIVER STUDY

Preliminary hydraulic studies of the Big Horn River have been accomplished as an aid in evaluating the structure costs for the two alternate crossings. Approximately 33

miles upstream from the proposed crossing, and currently under construction, is the Bureau of Reclamation's Yellow Tail Dam. The dam is scheduled for completion in 1965, and based upon a 50 year frequency, will have a design flood control release of 20,000 c.f.s.

The watershed area between Hardin and the dam is approximately 1,115 square miles. To determine runoff from this area, methods and charts contained in the U.S. Department of Interior, Geological Survey publication titled "Floods in Eastern Montana Magnitude and Frequency" were used. This report was prepared in cooperation with the Montana State Highway Commission in May of 1958. An additional 50 year discharge of 9,550 c.f.s. was determined, and when added to that of the dam, yielded a design discharge of 29,550 c.f.s. at the bridge site.

The Geological Survey operated a gaging station near Hardin at the present Chicago, Burlington and Quincy Railroad bridge from 1904 through 1917 and at the present U.S. 87 Highway bridge from 1918 to 1933. These records indicated that a mean velocity of approximately 7 f.p.s. occurred during discharges of 28,000 to 30,000 c.f.s. If this velocity is still valid a waterway area of 4,200 square feet would be required. This was the basis used for determining the approximate bridge lengths required for each study line.

C. BRIDGES - ALTERNATE LINES

1. A Line

This route requires 9 bridge sites of normal proportions plus the long crossing of the Big Horn River. Of the 10 locations, Sites A-1 through A-6 are single bridges and Sites A-7 through A-10 are twin bridges.

2. B Line

Eight bridge locations are required for this route. All sites are single bridges except B-6 and B-8 which are twin bridges. Sites B-3 and B-8 require long bridges due to a combination of multiple crossings and heavy skew angles. Site B-6 crosses the Big Horn River on a relatively high alignment and thereby requires exceedingly long bridges. Based upon preliminary soils investigations, this crossing will require extensive protection along the east bank of the river.

3. E Line

Bridge requirements for this line are essentially identical to that of the A Line. Sites 1, 2, 7, 8, 9 and 10 are at the same location for both lines. Sites 3, 4, 5 and 6 provide crossings for the same features at different locations.

TABLE B-I

ESTIMATED BRIDGE COSTS

	Site No.	Length Feet	Width Feet	Area Sq. Ft.	Est. Cost per Sq. Ft.	Cost
A LINE:	A-1	178	31	5,518	$10.00	$ 55,180
	A-2	110	47	5,170	10.00	51,700
	A-3	111	47	5,217	10.00	52,170
	A-4	163	47	7,661	11.00	84,271
	A-5	186	31	5,766	10.25	59,102
	A-6	204	27	5,508	10.25	56,457
	A-7	615	62	38,130	20.00	762,600
	A-8	132	82	10,824	10.25	110,946
	A-9	189	82	15,498	11.25	174,353
	A-10	245	82	20,090	11.50	231,035
					Total A Line	$1,637,814
B LINE:	B-1	177	31	5,487	$10.00	$ 54,870
	B-2	212	31	6,572	10.50	69,006
	B-3	404	31	12,524	11.50	144,026
	B-4	111	47	5,217	10.00	52,170
	B-5	181	31	5,611	10.25	57,513
	B-6	668	62	41,416	23.00	952,568
	B-7	254	31	7,874	10.25	80,709
	B-8	500	62	31,000	11.50	356,500
					Total B Line	$1,767,362
E LINE:	E-1	178	31	5,518	$10.00	$ 55,180
	E-2	110	47	5,170	10.00	51,700
	E-3	111	47	5,217	10.00	52,170
	E-4	148	47	6,956	11.00	76,516
	E-5	112	47	5,264	10.25	53,956
	E-6	204	27	5,508	10.25	56,457
	E-7	615	62	38,130	20.00	762,600
	E-8	132	82	10,824	10.25	110,946
	E-9	189	82	15,498	11.25	174,353
	E-10	245	82	20,090	11.50	231,035
					Total E Line	$1,624,913

P A R T I V

SOILS AND GEOLOGY

A. INTRODUCTION

Geology has an important effect on the choice of alternate road alignments, especially in the western half of the project. A preliminary appraisal of the effect of the subsoil on bridge foundations and pavement section and thickness is given. Regional geology and subsurface soil conditions are discussed below and shown on Figure S-1 and Table S-1.

B. GEOLOGY

The entire project is underlain by Cretaceous shale hundreds of feet thick. In the western half of the project shale outcrops are covered by an overburden only two or three feet thick. The shale beds are horizontal or have a very slight dip. There are no igneous or metamorphic rock in the vicinity. In the river valleys wide channels have been eroded by the Big Horn and Little Big Horn and then 15 to 20 feet of alluvium has been deposited. The Little Big Horn River has changed its course many times leaving numerous ox-bow ponds as remnants of its previous channel. The ox-bows are filled with water and their bottoms are covered with thin marshy deposits. About 100 feet of shale is exposed on the high bluff just east of

SHALE - TELEGRAPH

SHALE - NIOBRARA

A 1 A 2 A 3 A 4 "A" LINE A 5 A 6

"B" LINE B 1 B 2 B 3 B 4 B 5

"E" LINE

HARDIN

TERRACE #2

TERRACE #1

C.B. & Q. R.R.

Bighorn River

A1 A2 A3 A4 B1 B2 B3 A5 B4 A6 B5

0' 1' 25'

0' 1' 25'

0' 1' 25'

0' 25'

0' 10' 20'

0' 20'

0' 13'

0' 10'

0' 16' 35'

0' 15' 45'

0' 15' 21'

LEAN CLAY

SILTY SAND

SILTY GRAVEL

SHALE NIOBRARA

SHALE TELEGRAPH

GEOLOGY MAP & SOIL PROFILE

PROJECT I-90-9(8)471

HARDIN , MONTANA

FIGURE S-1

TABLE S-I

SOIL CLASSIFICATION DATA

Station	Depth	Liquid Limit	Plast. Index	Pass #200	Group Index	Class	*Feature
A, B&E 1540	2'	59	30	90	20	A-7-6	Kcnc
A&E 1660 (2000' south)	8'	46	26	85	15	A-7-6	Kcnc
A&E 1710 (3300' south)	4'	55	43	87	19	A-7-6	Kcnc
A&E 1720 (3300' south)	3'	180	148	95	20+	A-7-6	Bentonite
A 1840	15'	45	25	99	15	A-7-6	Kct
B 1970	2'	36.5	19.5	93	12	A-6	Qt_2
A 2102	2'	30	9	30	0	A-2-4	Qt_1

* Note:

Kcnc Niobrara Shale

Kct Telegraph Shale

Qt_1 First River Terrace

Qt_2 Second River Terrace

Hardin. This bluff was protected from erosion by a cap of terrace gravels about 25 feet thick.

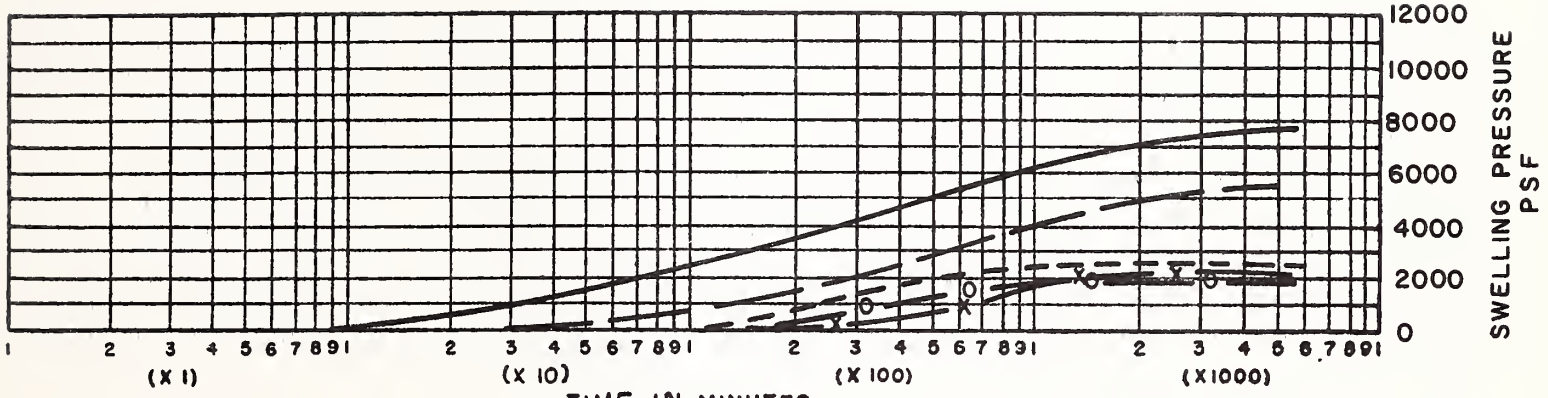
Hardin townsite is located on the first terrace above the Big Horn River. Soils comprising the valley and this terrace are principally silty sands with occasional sandy gravel deposits at depth. Two miles west of town and about 70 to 80 feet higher in elevation, there is a second river terrace comprised principally of lean clay. Small gravel deposits are currently being mined around the perimeter of the second terrace. Farther west beginning about Station 1900+00 on the A Line and 1850+00 on the B Line, Cretaceous shale formations rise within a few feet of the surface and this situation continues to the west end of the project. The term shale is used here to indicate an ancient deposit of clay which has been heavily precompressed by thousands of feet of overburden in the geologic past. This pressure has compacted it heavily and squeezed out a large percentage of moisture. The material still possesses many of the qualities of a fat clay, however. Compared to ordinary soils, shale is relatively hard but it is not in the same class with hard crystaline bedrock. Cretaceous shales are divided geologically into two members with significantly different engineering characteristics. The lower member, the Niobrara, is a fat black

shale clay containing several seams of bentonite. The Niobrara has a high plasticity index and is subject to large changes in volume following changes in moisture content. Black Niobrara shale is overlain by the Telegraph Formation, a sandy bluff colored shale. The Telegraph has a lower plasticity, its potential volume change is considerably less, and it is not known to contain bentonite. See Figures S-2 and S-3 for the results of swell tests on the shale formations.

More erosion resistant Telegraph Creek Formation makes up most of the higher ground of Lines A and B, thus cuts are principally through the Telegraph Formation and Black Niobrara shale is exposed only in the valleys and draws. The coincidental lines from Station 1600 to the west are underlain by Niobrara shale.

C. ROADWAY AND PAVEMENT

Small portions of the alignments are in expansive black Niobrara shale on Line B from Station 1850 and part of Line A from Station 1900 to the west to Station 1650 and present serious problems for construction of high type highway pavements requiring deep cuts and strict surface tolerances. From Station 1650 west all of the cuts will be in the Niobrara shale. It



SWELL TEST

	1	2	3	4	5
TEST HOLE	A 1	A 1	A 3	A 4	A 4
DEPTH	25'	15'	15'	5'	25'
SOIL TYPE					
MOISTURE *INITIAL*	14.7	14.0	14.5	13.2	16.3
MOISTURE *FINAL*	18.8	17.5	19.0	15.6	19.1
NATURAL DRY DENSITY	116	119	112.5	123	112

INDEX

NIOBRARA SHALE

——————— 1

— — — — 2

TELEGRAPH SHALE

— — — — — — 3

——x——x—— 4

——o——o—— 5

FIGURE S-2

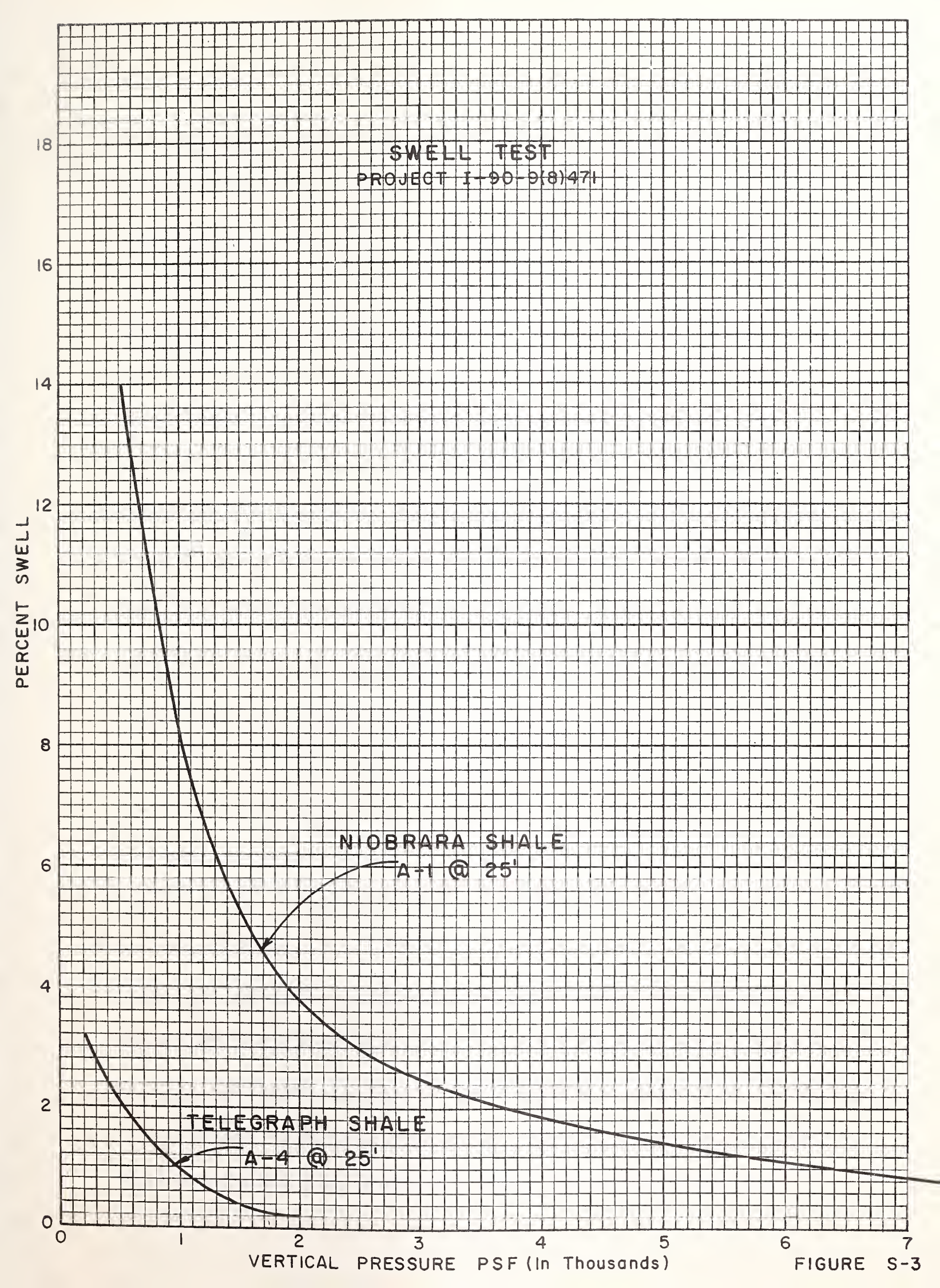

SWELL TEST
PROJECT I-90-9(8)471
PERCENT SWELL
0
2
4
6
8
10
12
14
16
18
NIOBRARA SHALE
A-1 @ 25'
TELEGRAPH SHALE
A-4 @ 25'
0
1
2
3
4
5
6
7
VERTICAL PRESSURE PSF (In Thousands)

FIGURE S-3

is very difficult to prevent this shale from swelling. In the deep cuts up to one foot of heave is anticipated. A large decrease of shear strength accompanies expansion, necessitating a thick pavement section to prevent shear failures. These undesirable characteristics of the prospective subgrade plus a heavy concentration of sulfate salts (which attack concrete) practically preclude consideration of a rigid Portland Cement Concrete pavement. The flexible qualities of asphalt concrete allow it to conform to an irregular surface. Exceptionally deep subbases will be required over Niobrara shale.

Heaving is not too apparent on existing U.S. 87 because there are only a few shallow cuts and the road was not built to strict surface tolerance, thereby obscuring its effect. Shale in-situ in deep cuts expands considerably more than the same material placed in embankments. This is particularly true if abundant water is added during compaction of the embankments.

Slope failures are frequently found in deep cuts in shale, caused by a gradual softening of the shale through percolation of the water in cracks and fissures. Existence of bentonite seams vastly increases the chances of slides. From this standpoint the Telegraph Creek Formation along the

alternates shown is more desirable than the Nibrara Formation to the south.

After leaving the shaley uplands east of Station 1900 Line A and 1850 Line B no special roadway problems are anticipated. Subgrades are ordinary lean clay and silty sand. Line B cuts through the high bluff, east of the Big Horn, and there are numerous landslides visible along both sides of this bluff. Some have been caused simply by the rivers undercutting the toe of the slope producing a slide. Others have been caused by a gradual softening of the very stiff shale due to infiltration of water from above which has reduced the shear strength until the slope is no longer stable. The former slides can be prevented in the cut by merely laying the side slopes back on an angle somewhat less than the natural angle of repose. The latter slides, due to softening, cannot be prevented so easily; however, the evidence available now indicates that the particular condition required for softening occurs south of the airport located on the bluff southeast of Hardin, but probably not to the north.

Finished grades of both lines in the valley of the Little Big Horn should be kept high to provide adequate freeboard above the shallow water table. Silty sand soil predominates and there are no other special problems foreseen in this valley.

D. BRIDGE FOUNDATIONS

Valley fills of the Little and Big Horn Rivers are from 15 to 20 feet thick and consist of sand, gravel and silt with black shale underlying the valley fills. Pile foundations for all bridges located in both valleys are indicated by erosion considerations and by the relatively shallow depth to a competent shale bearing strata.

There appears to be a serious erosion problem on the east abutment of the Big Horn crossing Line B, where the river is actively undercutting the bluff.

Grade separations located on the first and second terraces west of Hardin can probably be founded on shallow footings bearing on alluvium. Grade separations on shale beds farther west will be founded on the shale using shallow foundations (pads or short piers) designed to exert large dead load pressures to prevent expansion.

E. SUMMARY

1. Aerial geology favors keeping the alignments north of the expansive Niobrara shale in the western portion of the study area. Geologically, Line A has a more desirable location for crossing the Big Horn River east of Hardin due to the deep cut required

through the bluff east of Hardin on the B Line, as well as the erosion problem caused by cutting of the bluff at the proposed bridge site at the Big Horn River on the B Line.

2. Thick subbases and special construction will be required in the west portion over the Niobrara shale where encountered.

3. Location of adequate aggregate sources within a reasonable distance for construction of the highway may be difficult.

4. Piling of moderate length is indicated for river bridges, shallow spread footings appear practical for grade separations.

P A R T V

RECOMMENDATIONS

A. ALIGNMENT

It is recommended by this firm that the A Line as shown on the attached plans be adopted as the routing for Interstate 90 through this study area. Economically, the B Line has a slight advantage over the other alternates but other factors should be considered in the choice, as indicated below.

1. The vertical and horizontal alignment of B Line are not as desirable as A Line.
2. An at grade crossing of the main line of the C.B. & Q. Railroad tracks will be introduced for reasonably heavy traffic at the Center Avenue interchange on B Line. Operating on this railroad are two through freight trains, two through passenger trains, and one local train. In addition during harvest season, as much as 8 hours per day of switching will occur in this area.
3. Protection of the east abutment for the Big Horn River Bridge will be a problem on the B Line due to the tendency of the Big Horn to erode the shale bluff in the crossing area.

4. Maintenance of traffic during construction will be simplified by using the A Line since construction activity will not be in the vicinity of existing U.S. 87 except for a short segment on the east end.

5. Access to private lands can be served better with the construction of the A Line since U.S. 87 will remain to service the areas.

6. The E Line has slightly less economic advantage than the A Line and will disrupt more improved properties. In addition, the E Line would separate a residential area from the city thereby complicating future growth in the area.

B. LANEAGE

It is recommended that two lanes be constructed on the A Line from Sta. 1530+00 to Sta. 2190+00, and four lanes be constructed from Sta. 2190+00 to Sta. 2336+00.

For the two-lane section recommended the highway should be designed and located on the right-of-way so that an additional two-lane pavement can be added in the future to form a divided highway. This would comply with "A Policy on Design Standards, Interstate System" as published by American Association of State Highway Officials, revised 12 April 1963.

C. INTERCHANGES

It is recommended that interchanges as shown on the plan sheets for A Line be adopted. Annual savings will result and adequate service provided to the area.

INDEX OF SHEETS

1	TITLE SHEET
2-3	TYPICAL SECTIONS
4-15	PLAN & PROFILE
16	BRIDGE LAYOUT CRITERIA

STATE OF MONTANA

STATE HIGHWAY COMMISSION

FED. ROAD DIV. NO.	STATE		FISCAL YEAR	SHEET NO.	TOTAL SHEETS
	MONT.			1	16

STATE NUMBER _____

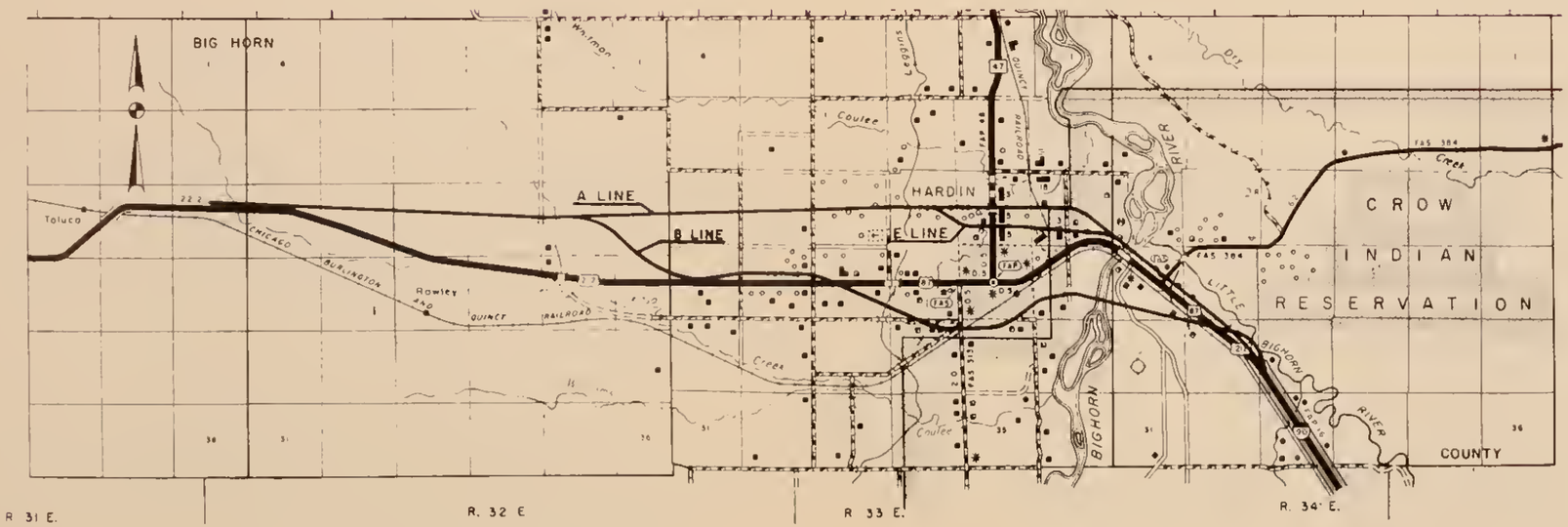
PLANS COMPLETED _____

CONTRACT COMPLETED _____

PLAN AND PROFILE OF PROPOSED
INTERSTATE 90 ROUTING
TOLUCA TO HARDIN

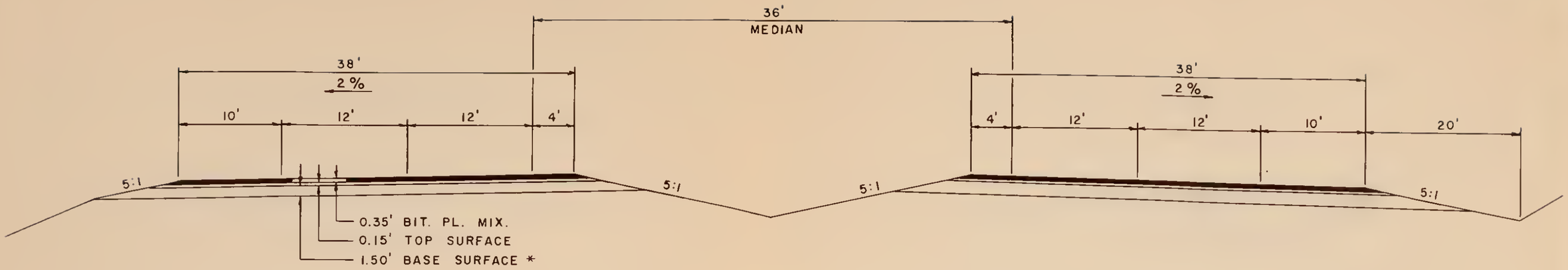
SCALES

HORIZONTAL: 1 Inch = 1000 Feet
VERTICAL: 1 Inch = 50 Feet

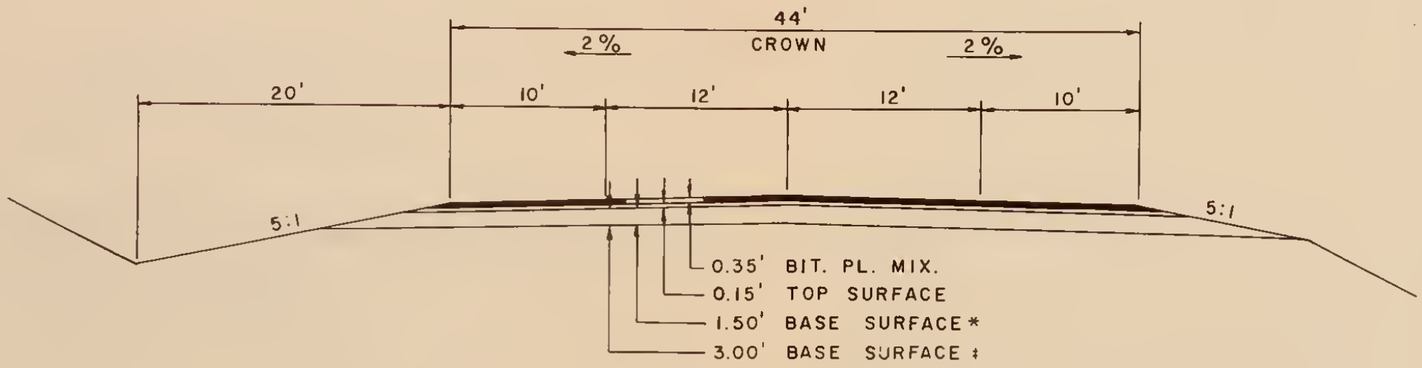


THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

SHEET NO.	TOTAL SHEETS
2	16



FOUR LANE
INTERSTATE



TWO LANE
INTERSTATE

‡ A, B & E LINES STA. 1530+00 TO 1640+00

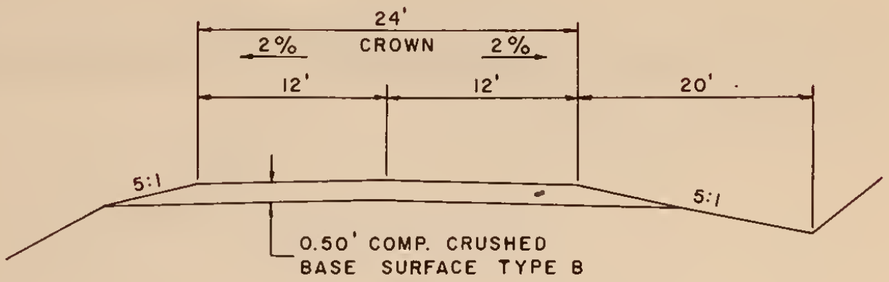
* A LINE STA. 1640+00 TO 2336+00
* B LINE STA. 1640+00 TO 2344+00
* E LINE STA. 1640+00 TO 2336+00

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

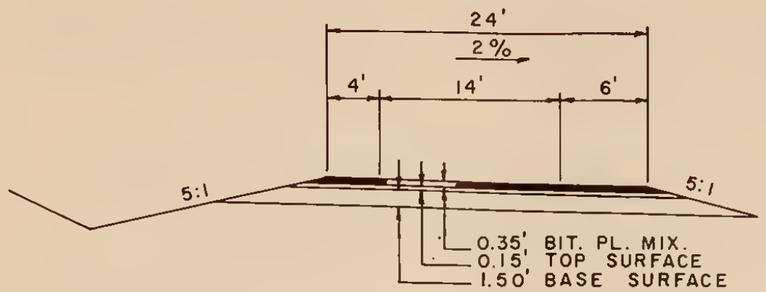
TYPICAL
ROADWAY SECTIONS

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

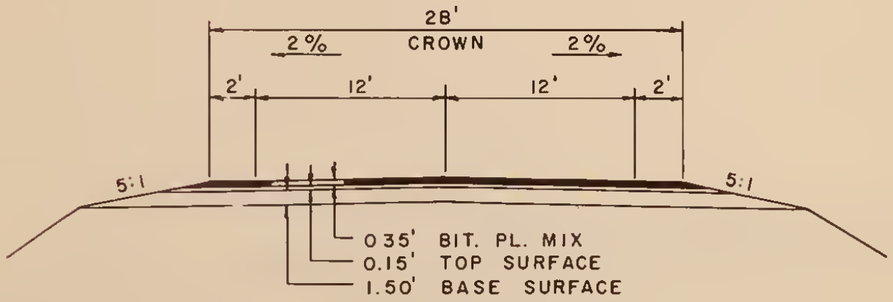
SHEET NO.	TOTAL SHEETS
3	16



FRONTAGE ROADS



INTERSTATE RAMPS



MONTANA 47 & U.S. 87

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

TYPICAL
ROADWAY SECTIONS

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

SHEET NO.	TOTAL SHEETS
4	16

BEGIN PROJECT I-90-9(8)471
STA. 1530+00

1550

1600

1650

A LINE

US 87

CBBORR

2 LANE

+0.39 %

-1.08 %

+1.56 %

3300
3250
3200
3150
3100

1530 40 1550 60 70 80 90 1600 10 20 30 40 1650 60 70 80

SHEET NO.	TOTAL SHEETS
5	16

A LINE

1700

1750

1800

2 LANE

-2.79%

+1.50%

-1.00%

+0.15%

+1.60%

3250

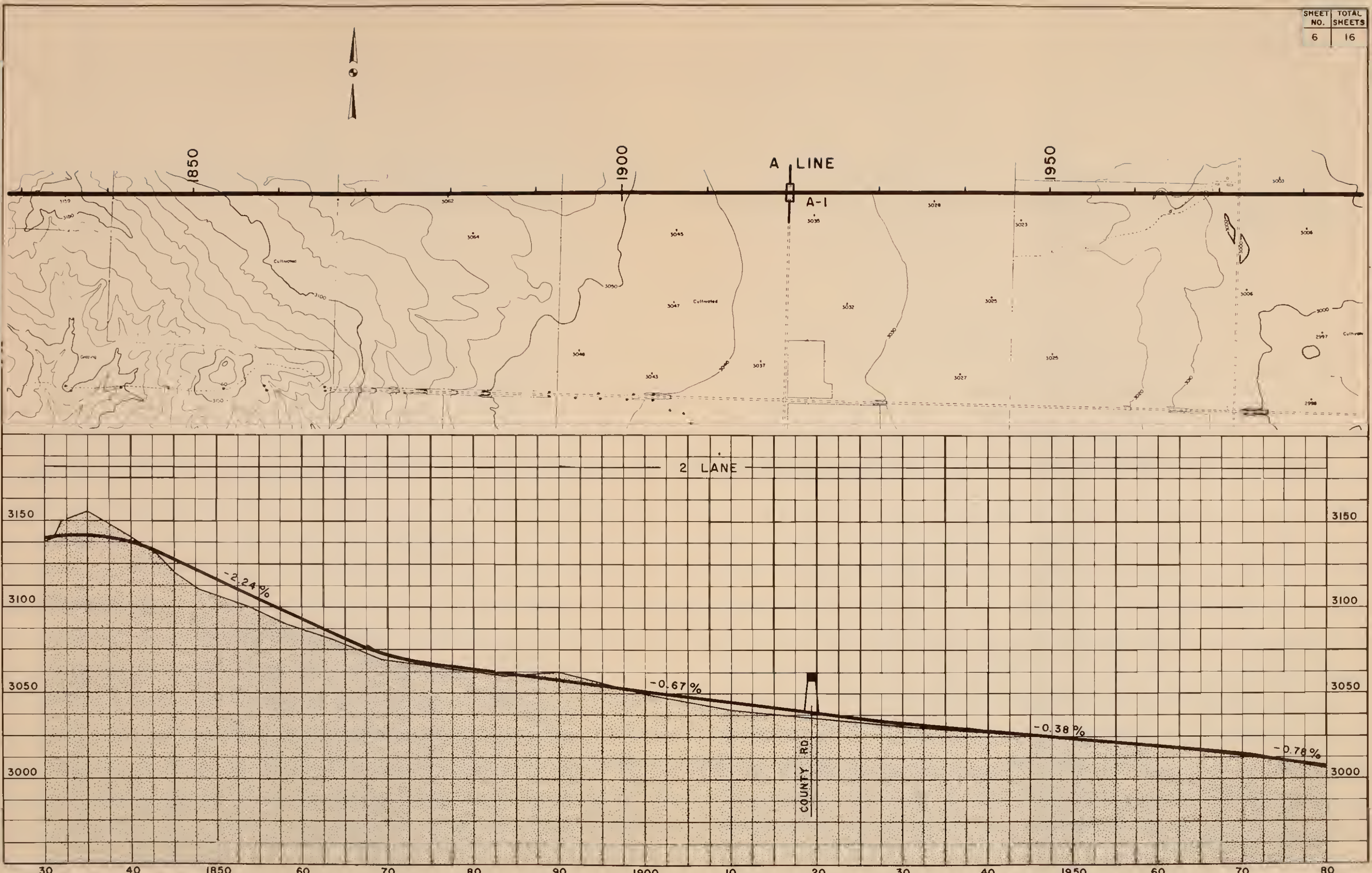
3200

3150

3100

80 90 1700 10 20 30 40 1750 60 70 80 90 1800 10 20 30

SHEET NO.	TOTAL SHEETS
6	16



SHEET NO.	TOTAL SHEETS
7	16

2000 2050 2100

A-2 A-3

A LINE

Cultivated Irrig

Cultivated

Cemetery

Montana 47

CO RD

HARDIN

2 LANE

3050 3000 2950 2900

-0.78 %

-1.12 %

-2.93 %

-0.28 %

+2.00%

-2.05 %

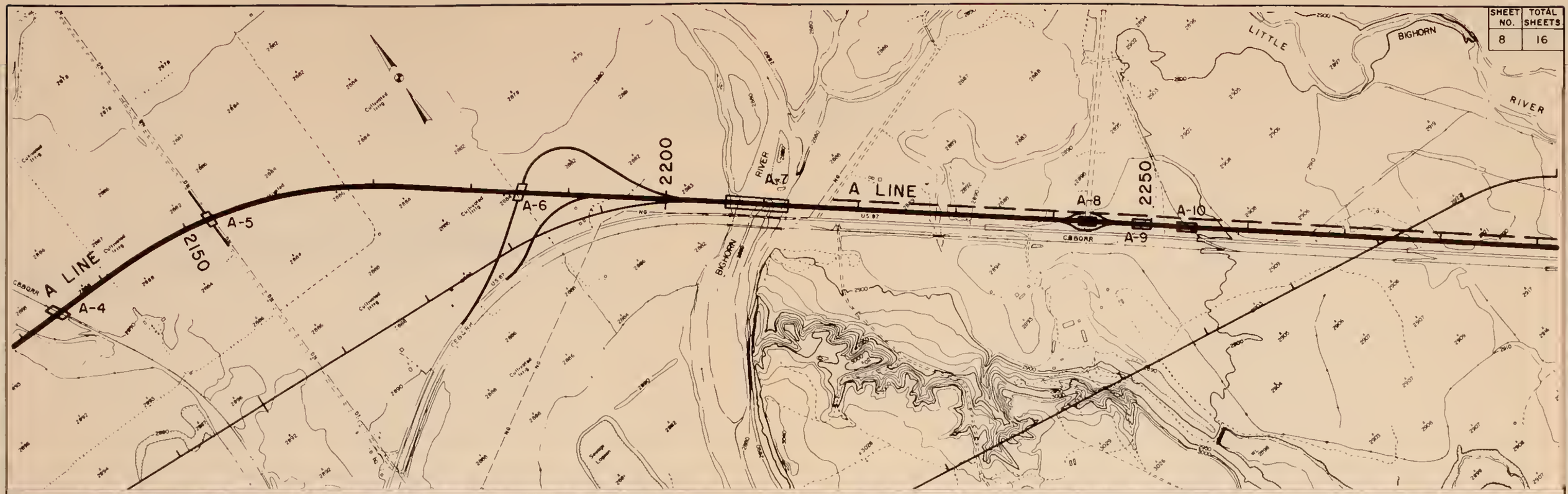
+2.00%

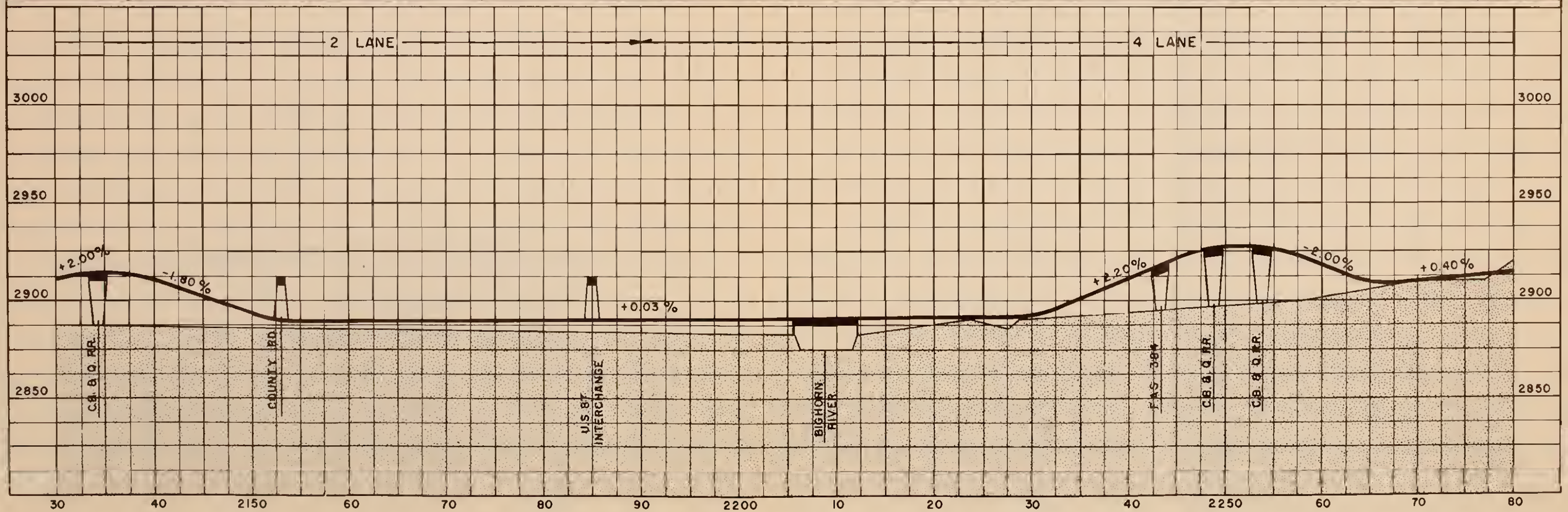
COUNTY RD

MONTANA 47

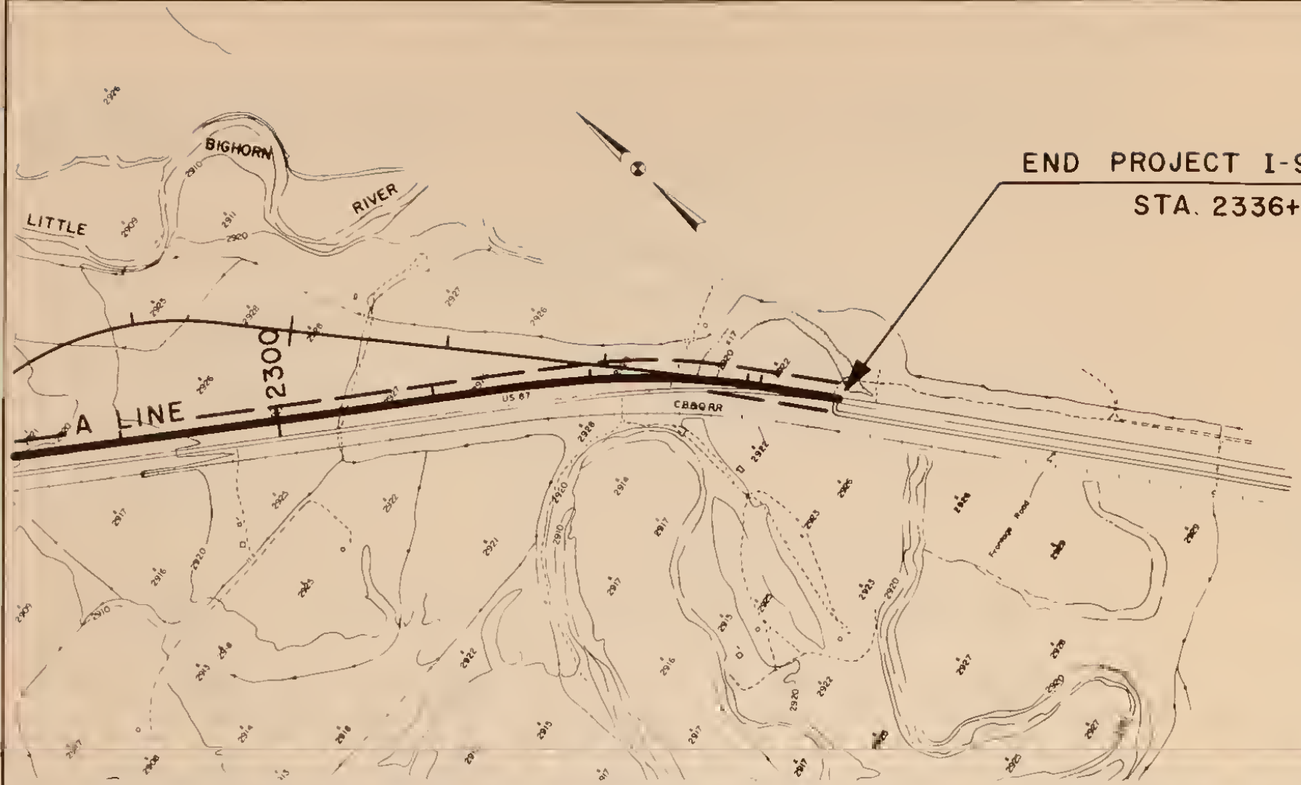
80 90 2000 10 20 30 40 2050 60 70 80 90 2100 10 20 30

SHEET NO.	TOTAL SHEETS
8	16





SHEET NO.	TOTAL SHEETS
9	16



SHEET NO.	TOTAL SHEETS
10	16

1800+00 A & B LINES =
1790+50 B LINE

1800

B LINE

1850

1900

2 LANE

1800+00 A & B LINES
1790+50 B LINE

+0.15%

-1.27%

-0.28%

3100

3050

3000

90 1800 10 20 30 40 1850 60 70 80 90 1900

SHEET NO.	TOTAL SHEETS
11	16

1850

B LINE

1900

B-1

1950

2 LANE

3150

3100

3050

3000

-0.28 %

-0.90 %

COUNTY RD.

30 40 1850 60 70 80 90 1900 10 20 30 40 1950 60 70 80

SHEET NO.	TOTAL SHEETS
12	16

B-2

2000

2050

B LINE

B-3

B-4

2100

US 87

THIRD ST

SECOND ST

FIRST ST

DIVISION ST

AVE

MITCHELL

LEWIS

MILES

TERRY

HOTEAU

CRAWFORD

GODY

CROW

CASTLE

CENTER

AIRPORT

FAIR GROUNDS

C B&QRR

2 LANE

3050

3000

2950

2900

-0.90%

-1.22%

-0.34%

+2.00%

-2.00%

-0.17%

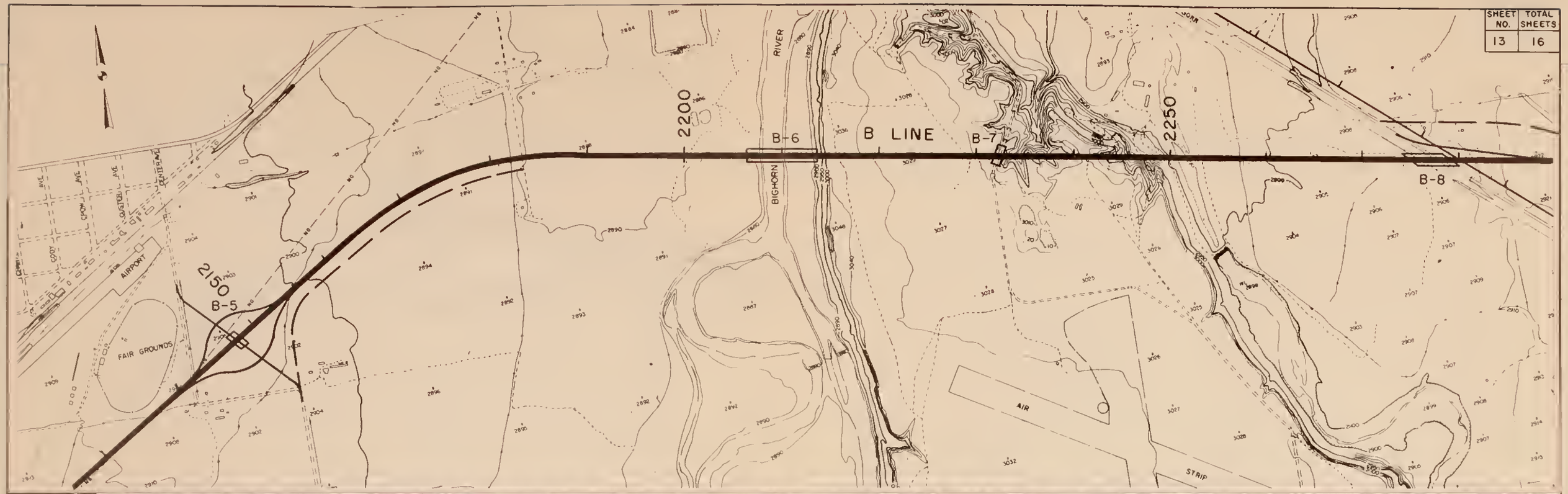
COUNTY RD

COUNTY RD C B&Q R R

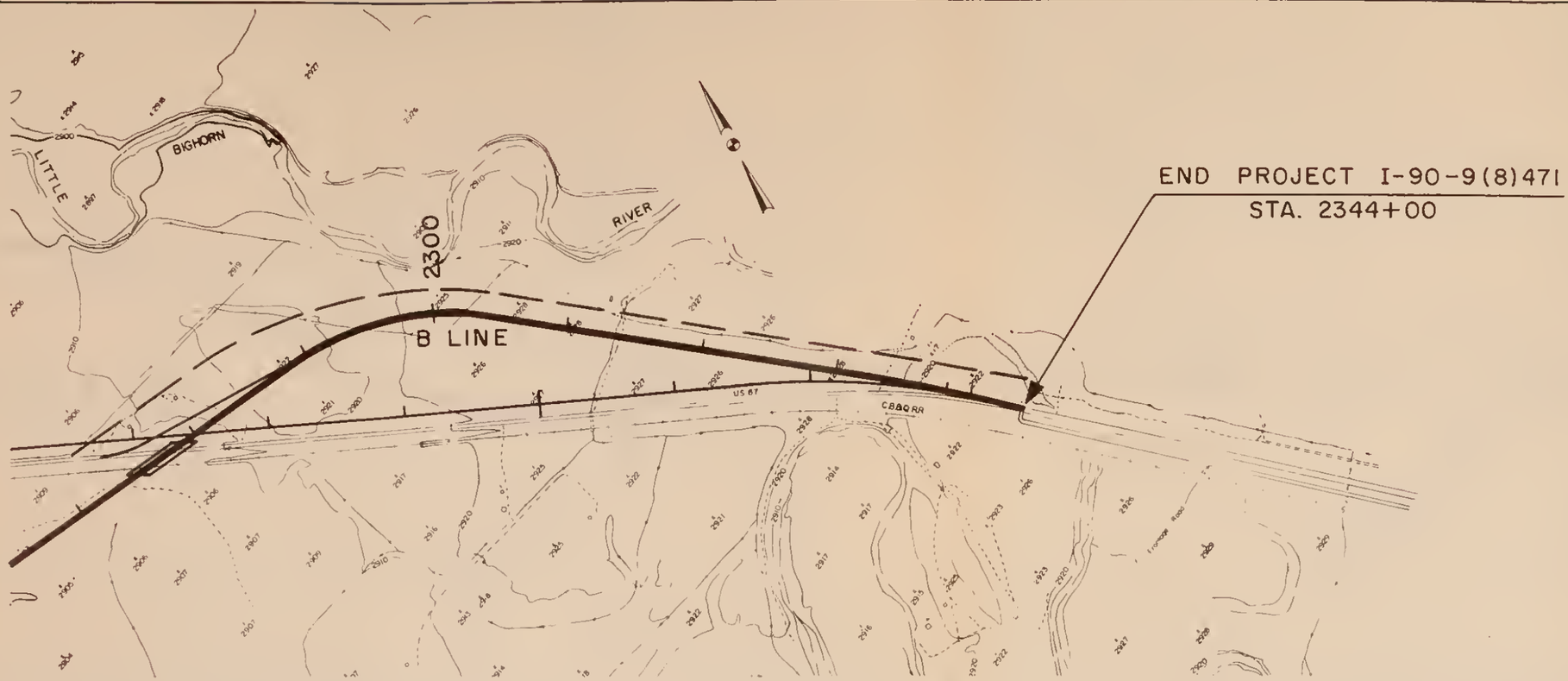
FAS 318

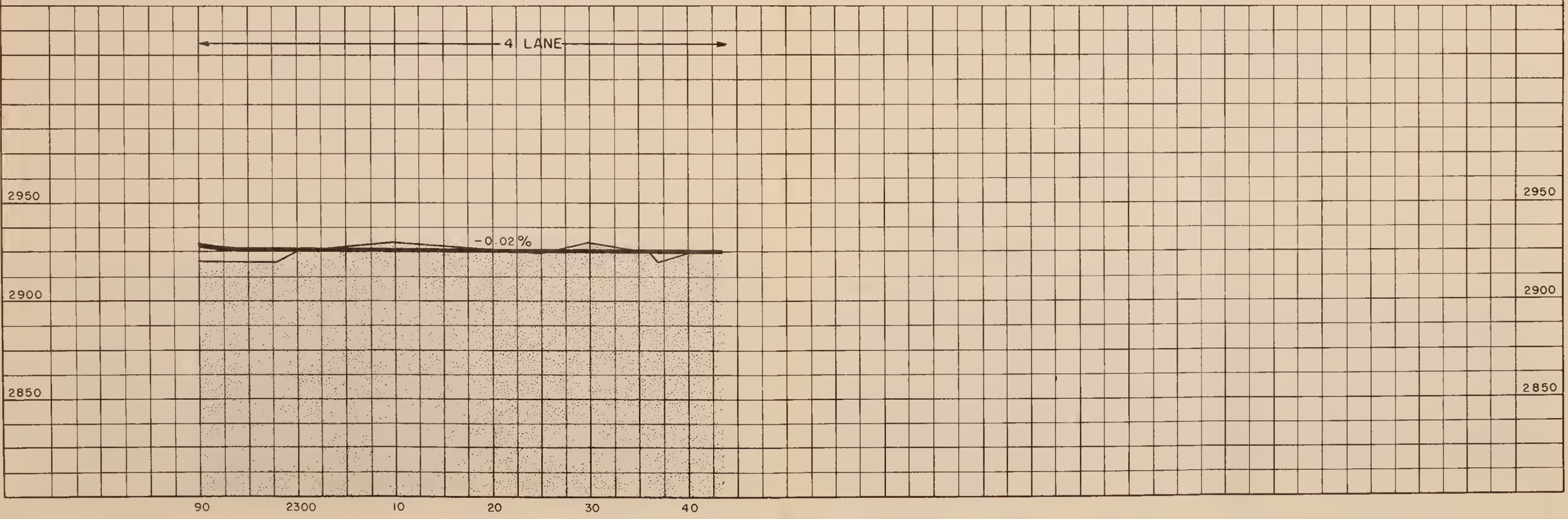
80 90 2000 10 20 30 40 2050 60 70 80 90 2100 10 20 30

SHEET NO.	TOTAL SHEETS
13	16



SHEET NO.	TOTAL SHEETS
14	16





SHEET NO.	TOTAL SHEETS
15	16

2050

2100

2150

2200

E LINE

E-3

E-4

E-5

E-6

2050 A LINE =
2050 E LINE

2200 E LINE =
2203 A LINE

HARDIN

Drive In Theater

Cultivated Irrig.

Meadow

Reg. Rm

US 87

RIVER

BIGHORN

2 LANE

4 LANE

3000

2950

2900

2850

-0.28 %

+2.00%

-2.00%

+2.00%

2.00 %

0.00 %

MONTANA 47

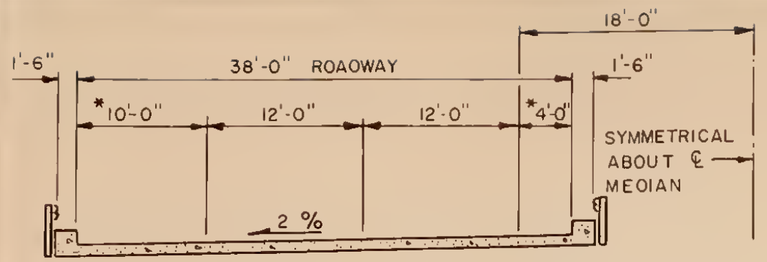
CROSSOVER

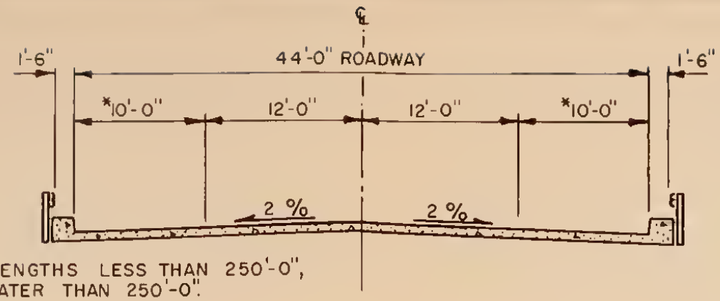
COUNTY RD.

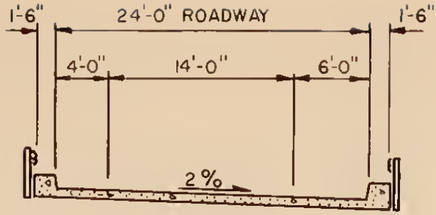
U.S. INTERCHANGE

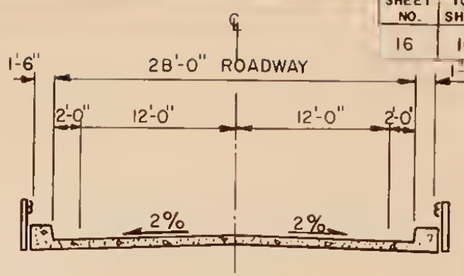
2050 60 70 80 90 2100 10 20 30 40 2150 60 70 80 90 2200

SHEET NO.	TOTAL SHEETS
16	16









*SHOULDER WIOTHS AS SHOWN FOR LENGTHS LESS THAN 250'-0", REDUCE TO 2'-0" FOR LENGTHS GREATER THAN 250'-0".

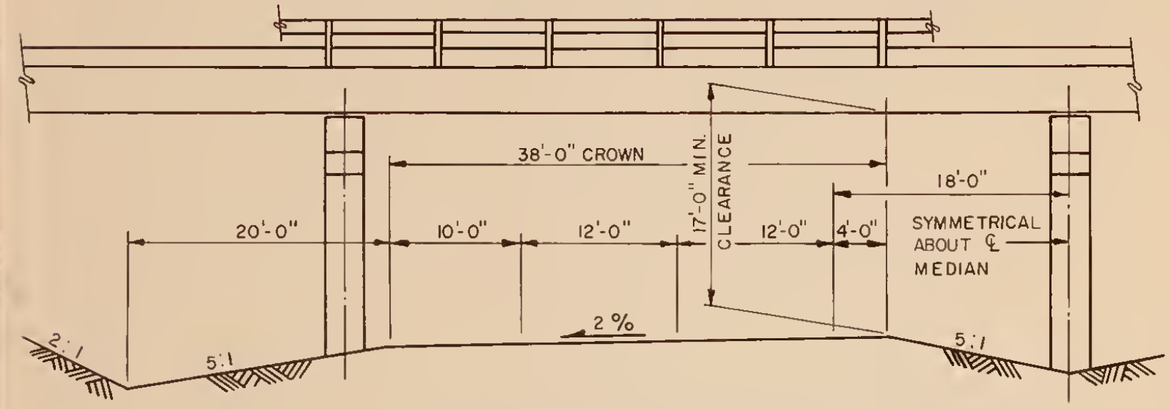
FOUR LANE INTERSTATE
(ONE HALF SHOWN)

TWO LANE INTERSTATE

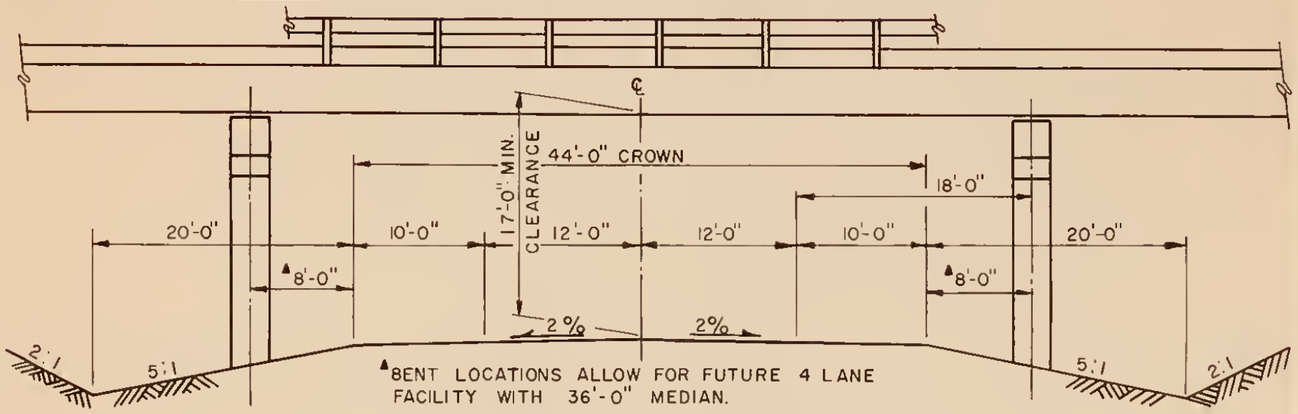
RAMP

COUNTY ROAD
CENTER AVE.

OVERPASS SECTIONS

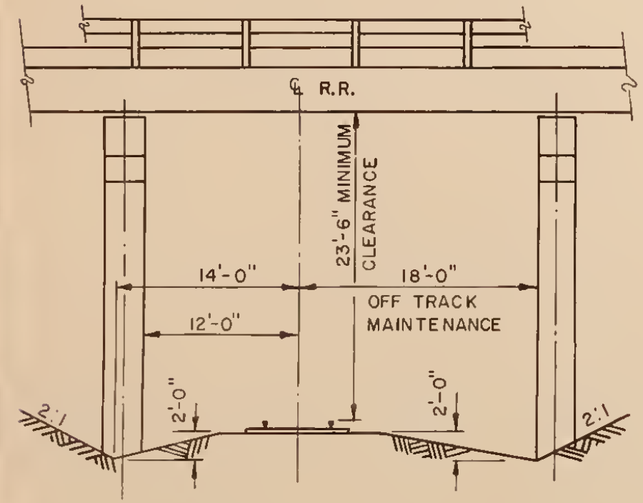


FOUR LANE INTERSTATE
(ONE HALF SHOWN)

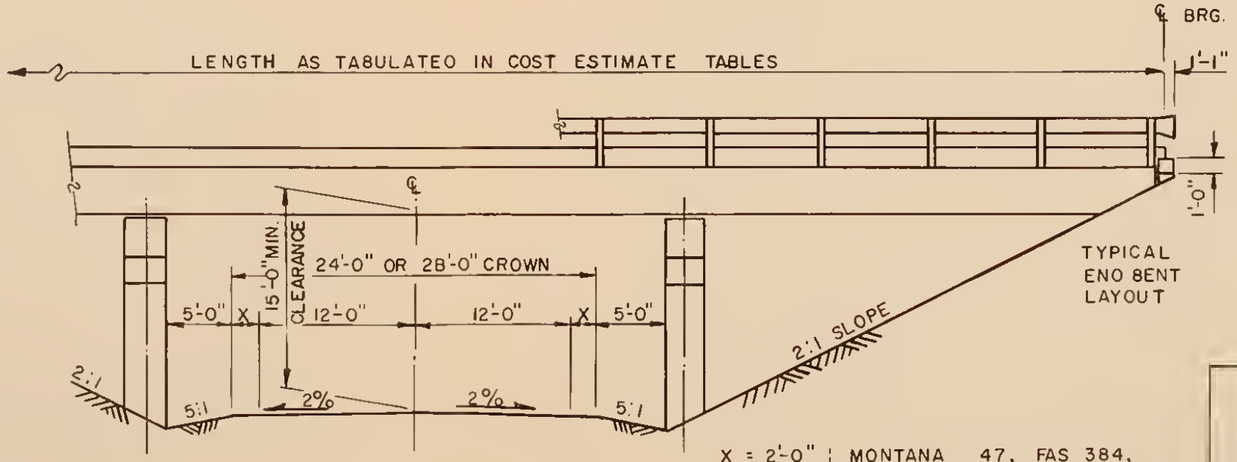


▲8ENT LOCATIONS ALLOW FOR FUTURE 4 LANE FACILITY WITH 36'-0" MEDIAN.

TWO LANE INTERSTATE



C.B. & Q. R.R.



LOCAL ROADS

X = 2'-0" : MONTANA 47, FAS 384, FAS 313 (MITCHELL AVE), AND U.S. 87.
X = 0'-0" : COUNTY ROADS.

UNDER PASS SECTIONS

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

BRIDGE LAYOUT CRITERIA

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO